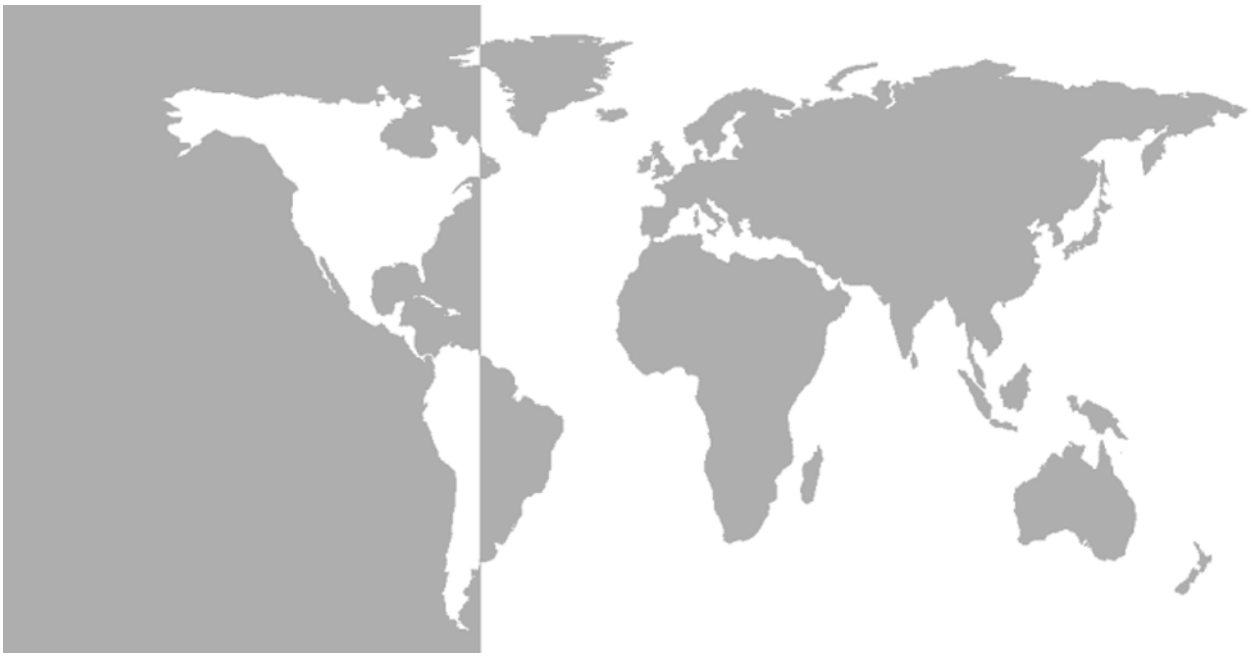
GE Infrastructure
Sensing



Moisture Target Series 5

Hygrometer

User's Manual

GE Infrastructure
Sensing

Moisture Target Series 5

Hygrometer

User's Manual

910-151E
November 2004

Moisture Target Series 5 is a GE Panametrics product. GE Panametrics has joined other GE high-technology sensing businesses under a new name—GE Infrastructure Sensing.

Warranty

Each instrument manufactured by GE Infrastructure Sensing, Inc. is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE Infrastructure Sensing, Inc. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE Infrastructure Sensing, Inc. determines that the equipment was defective, the warranty period is:

- one year for general electronic failures of the instrument
- one year for mechanical failures of the sensor

If GE Infrastructure Sensing, Inc. determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE Infrastructure Sensing, Inc., the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties of merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a GE Infrastructure Sensing, Inc. instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE Infrastructure Sensing, Inc., giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE Infrastructure Sensing, Inc. will issue a RETURN AUTHORIZATION number (RA), and shipping instructions for the return of the instrument to a service center will be provided.
2. If GE Infrastructure Sensing, Inc. instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.
3. Upon receipt, GE Infrastructure Sensing, Inc. will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
- If GE Infrastructure Sensing, Inc. determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner's approval to proceed, the instrument will be repaired and returned.

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Chapter 1

Features and Capabilities

Introduction 1-1

Electronics Unit 1-1

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Introduction

The *Moisture Target Series 5* is a microprocessor-based, single-channel hygrometer that measures moisture content in gases. It is intended for *Original Equipment Manufacturer* (OEM) applications, and is suitable for a wide range of process conditions that require real-time moisture measurement.

The *MTS 5* measures dew points from -80° to 20°C (-112° to 68°F), with data to -110°C (-166°F). It comes equipped with two standard alarm relays, one fault alarm relay, and a single analog output.

Electronics Unit

The *MTS 5* displays measurement data on a one-line, 6-digit liquid crystal display (LCD). You can program your unit and enter probe information using the keypad on the front panel (see Figure 1-1 below). The *MTS 5* accepts line voltages of 100, 120, 230 and 240 VAC, or 24 VDC.

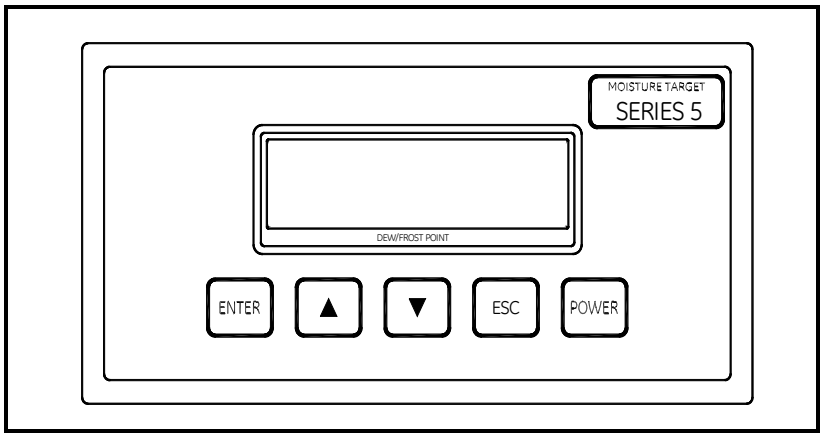

Figure 1-1: Front Panel

Probes

The moisture probe is the part of the system that comes in contact with the process. The *MTS 5* uses any M Series probe to measure dew point temperature in °C or °F. The sensor assembly is secured to the probe mount and protected with a sintered-stainless-steel shield (see Figure 1-2 below). Other types of shields are available.

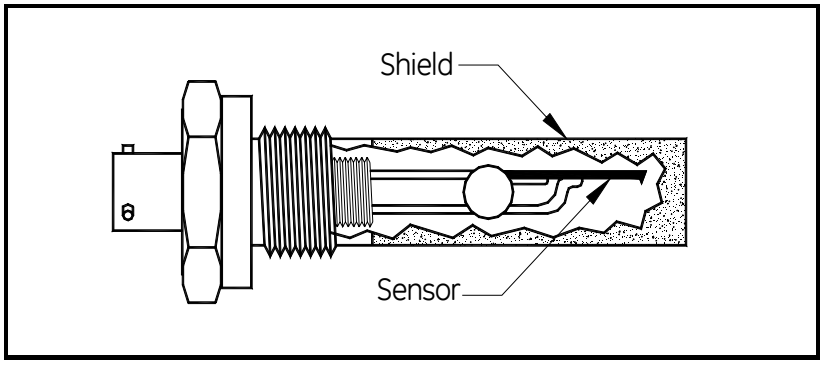

Figure 1-2: M Series Probe

Chapter 2

Installation

Introduction 2-1

Mounting the Electronics Unit 2-1

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Introduction

Installing the *MTS 5* includes:

- mounting the electronics unit
- mounting the sample system
- installing the probe into the sample system
- wiring the input power
- wiring the probe, recorder output, and alarm connections.

!WARNING!
To ensure safe operation, the *MTS 5* must be installed and operated as described in this manual. Also, be sure to follow all applicable local safety codes and regulations for installing electrical equipment.

Mounting the Electronics Unit

The standard *MTS 5* panel-mount unit can be installed in a rectangular cutout in a panel up to an inch thick (see Appendix B, *Outline and Installation Drawings*).

IMPORTANT: *For NEMA-4 and IP66 installation, the* MTS 5 *must be mounted in a rigid, flat panel using the panel gasket provided and all four mounting brackets (see Figure 2-1 below).*

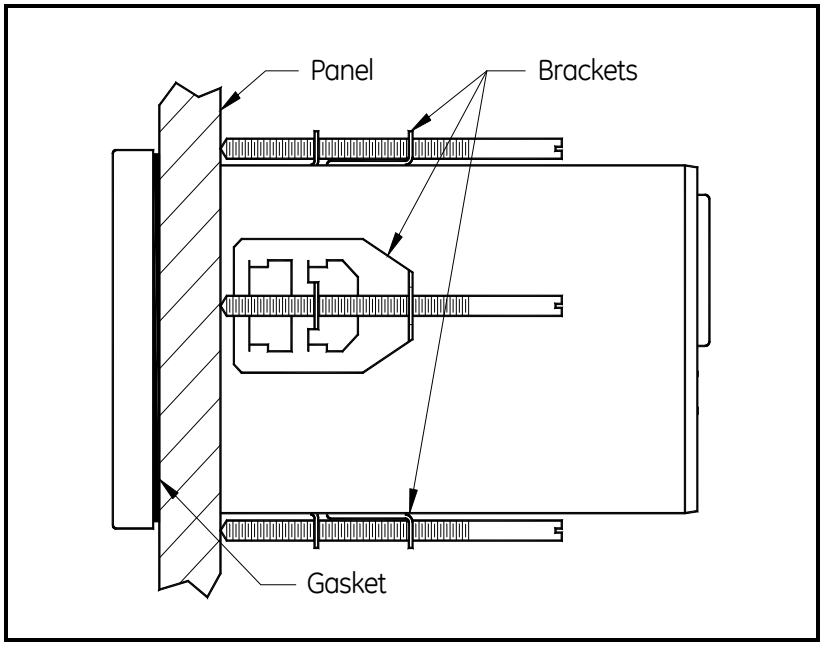


Figure 2-1: Mounting the *MTS 5* in a Panel

Mounting the Electronics Unit (cont.)

To mount the *MTS 5*, complete the following steps:

1. Remove the four clip-on mounting brackets from the unit (see Figure 2-1 on page 2-1).
2. Make sure the gasket is installed, then slide the meter into the front of the panel cutout.
3. Reinstall the four clip-on mounting brackets from behind the panel.
4. Secure the unit to the panel by tightening the four mounting bracket screws.

Mounting the Sample System

The sample system is normally fastened to a metal plate that has four mounting holes. GE Infrastructure Sensing can also provide the sample system in an enclosure if requested. If a sample system was ordered, outline and dimension drawings are included with the shipment. Follow the steps below to mount the sample system:

1. Fasten the sample system plate or enclosure with a bolt in each of the four corners.
2. Connect the sample system inlet to the process and the outlet to the return, using appropriate stainless steel fittings and tubing.

Caution!
Do not start a flow through the system until the probe has been properly installed.

Installing the Probe

GE Infrastructure Sensing probes are usually installed in a sample system. The sample system protects the probes from any damaging elements in the process. The probes are inserted into a cylindrical shaped container called the sample cell, which is included as part of your sample system. M2 probes have 3/4-16 straight threads, sealed with an o-ring, to secure the probe either into the sample system or directly into the process line. Other fittings are available for special applications.

Caution!
If the probe is to be mounted in the process line, consult GE Infrastructure Sensing for proper installation instructions and precautions.

Installing the Probe (cont.)

Refer to Figure 2-2 below, and follow these steps to install the probe into the sample cell:

1. Insert the probe into the sample cell so it is perpendicular to the sample inlet.
2. Screw the probe into the sample cell fitting, making sure not to cross the threads.
3. Tighten the probe securely. Figure 2-2 below shows a typical probe installed in a sample cell.

Caution!
For maximum protection of the aluminum oxide sensor, the stainless steel end cap should always be left in place.

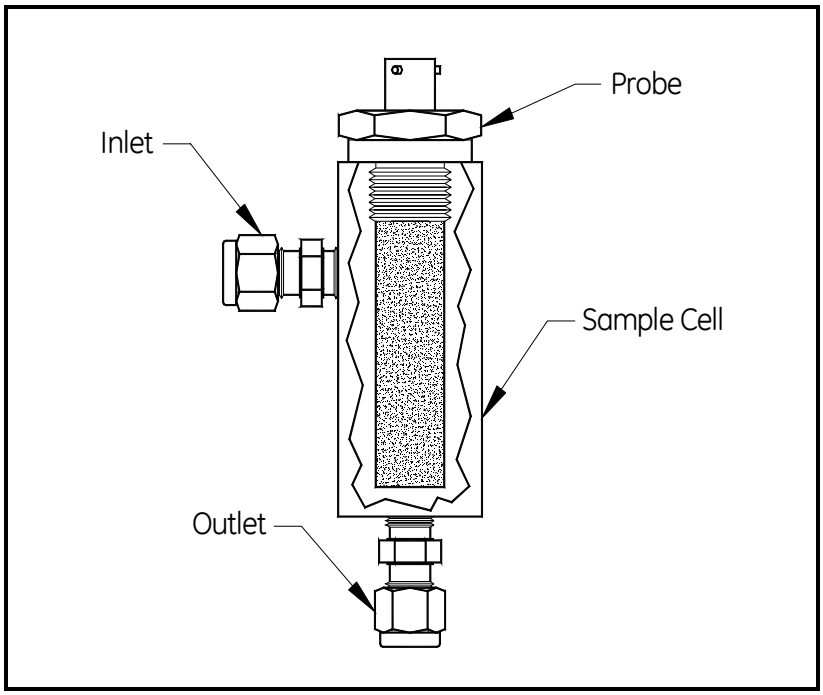


Figure 2-2: Probe Installed in Sample Cell

Making Wiring Connections

Wiring the *MTS 5* includes the following procedures:

- installing the power cable
- connecting the probe
- connecting the recorder output
- connecting the alarms

!WARNING!
To ensure safe operation, the *MTS 5* must be installed and operated as described in this manual. In addition, be sure to follow all applicable local safety codes and regulations for installing electrical equipment.

Installing the Power Cable

To install the power cable (included with the *MTS 5*), simply plug the female connector end into the male connector on the rear panel (see Figure 2-3 below).

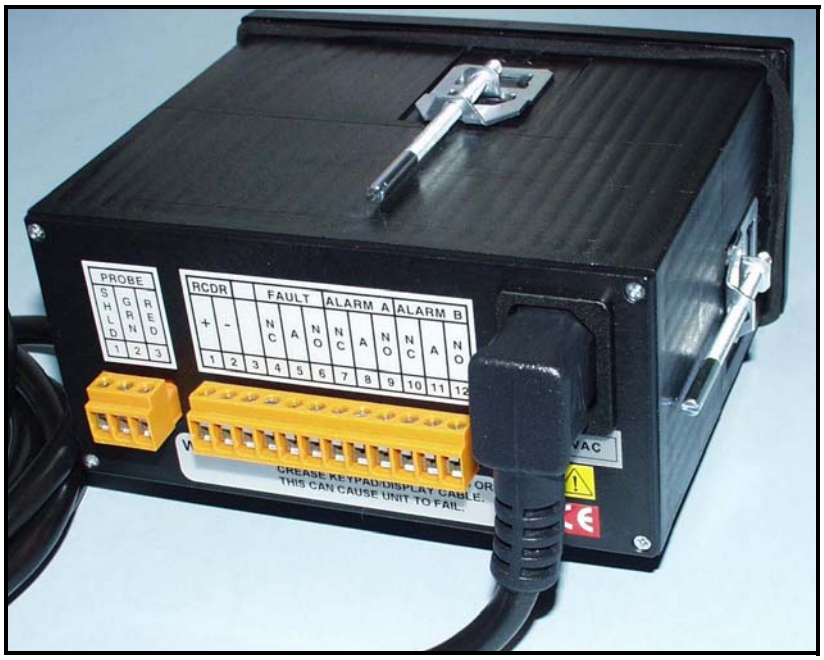


Figure 2-3: MTS 5 Rear Panel

Connecting the Probe

The probe must be connected to the *MTS 5* with a continuous run of GE Infrastructure Sensing two-wire shielded cable (see Figure 2-4 below). When connecting the probe, be sure to follow these guidelines for cable use:

- protect the cables from excessive strain (bending, pulling, etc.)
- do not subject the cables to temperatures above +65°C (149°F) or below -50°C (-58°F).

Note: *Standard cable assemblies (including connectors) can be ordered from GE Infrastructure Sensing in any length up to 600 meters (2000 feet).*

To connect the probe cable complete these steps:

1. Connect the cable to the probe by inserting the bayonet-type connector onto the probe and twisting the shell clockwise until it snaps into a locked position (approximately 1/8 turn).
2. Connect the probe cable (see Figure 2-4 below) to terminal block TB3 on the back of the *MTS 5* (see Figure 2-5 on page 2-6).

IMPORTANT: *To maintain good contact at each terminal block and to avoid damaging the pins on the connector, pull the connector straight off (not at an angle), make cable connections while the connector is away from the unit, and push the connector straight on (not at an angle) when the wiring is complete.*

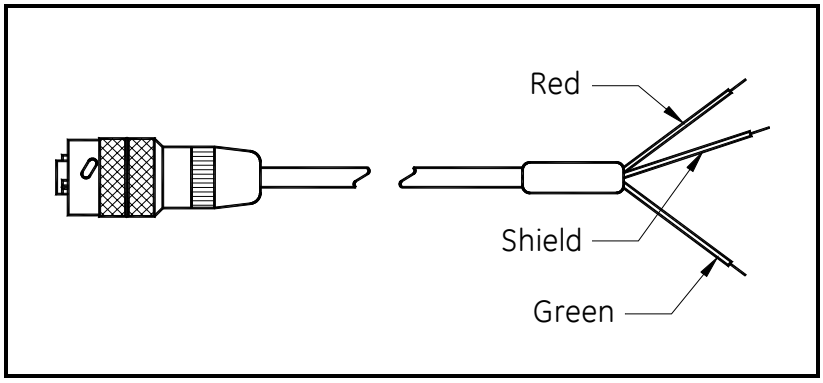


Figure 2-4: Probe Cable - Two Wire, Shielded

Connecting the Probe (cont.)

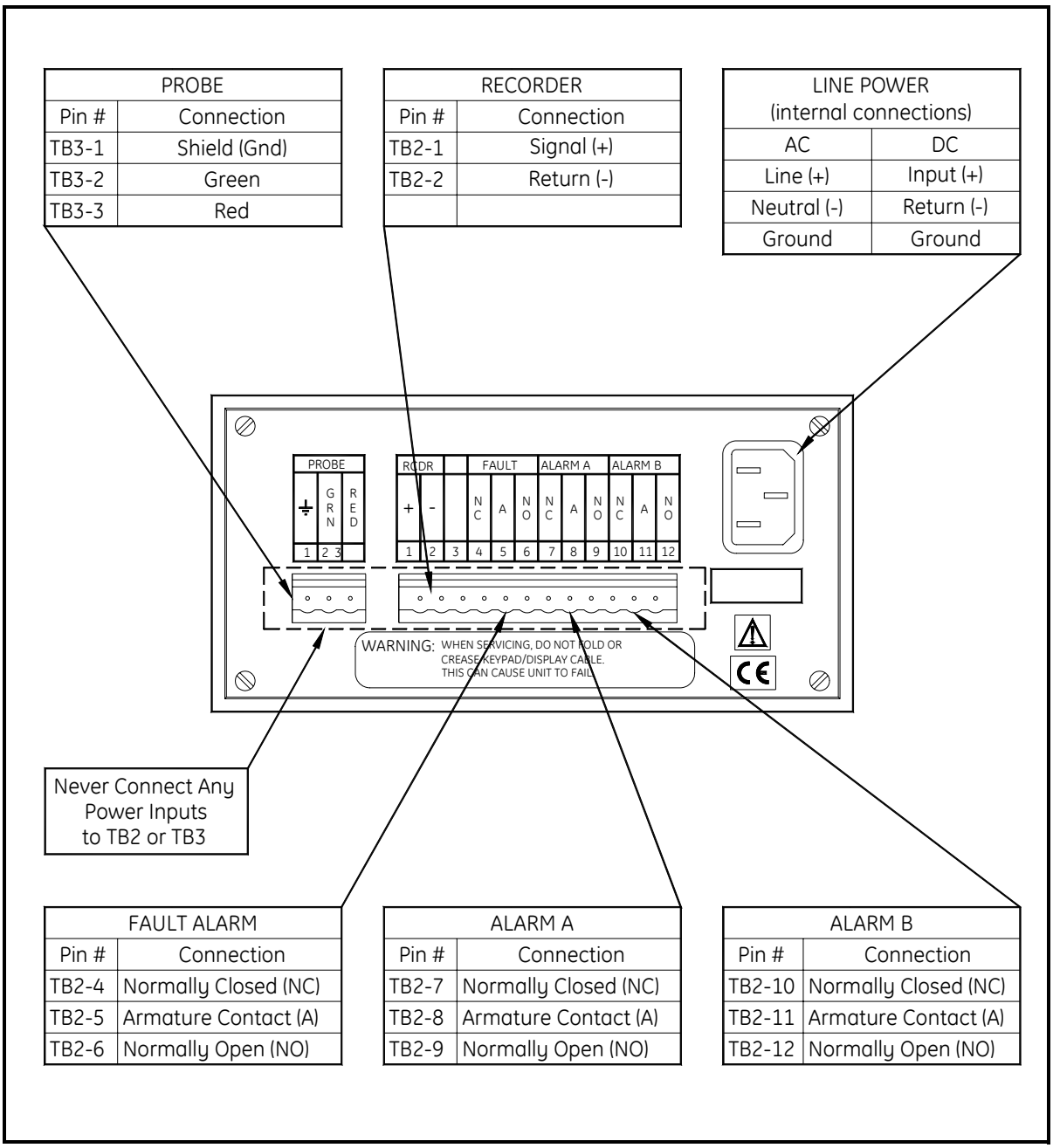


Figure 2-5: Back Panel Wiring Connections

Connecting the Recorder Output

The *MTS 5* has one isolated analog recorder output. Connect your recorder to terminal block TB2 on the back of the *MTS 5*, as shown in Figure 2-5 on page 2-6.

!WARNING!
Never connect line voltage or any other power input to the recorder output terminals.

This output provides either a current or voltage signal, which is set using switch S1 on the main PC board. The *MTS 5* is configured at the factory, but you should check the switch position before making connections. Follow these steps to check or reset switch S1:

1. Make sure the *MTS 5* is turned off and unplugged.

!WARNING!
You must disconnect line power before opening the *MTS 5* enclosure.

2. Remove the back cover of the enclosure by removing four screws.

IMPORTANT: *When you remove the back cover and main PC board, do not dislodge or disconnect the flexible jumper that connects the display to the main PC board. Remove the board from the enclosure only far enough to reach switch S1.*

3. Slowly slide the main PC board from the enclosure by pulling straight back, being careful not to dislodge the flexible jumper.
4. Locate switch block S1, shown in Figure 2-6 on page 2-8.
5. Set switch S1 in the appropriate position: I for current or V for voltage.
6. After you set the switch, slide the main PC board back into the enclosure and fasten the screws on the back cover

Connect the recorder output to terminal block TB2 on the back of the *MTS 5* as shown in Figure 2-5 on page 2-6.

IMPORTANT: *To maintain good contact at each terminal block and to avoid damaging the pins on the connector, pull the connector straight off (not at an angle), make cable connections while the connector is away from the unit, and push the connector straight on (not at an angle) when the wiring is complete.*

Connecting the Recorder Output (cont.)

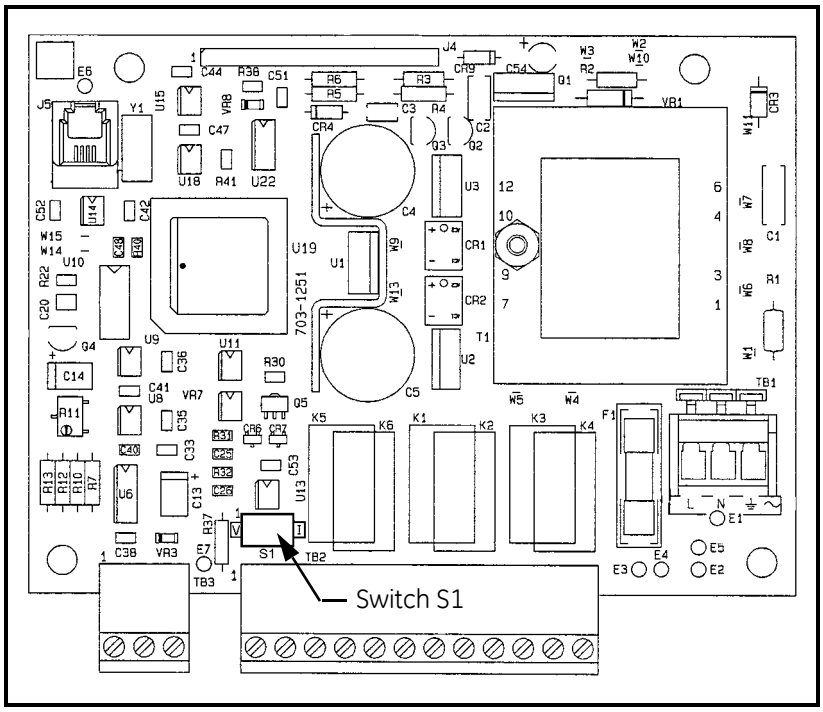


Figure 2-6: Switch S1 on the Main PC Board

Connecting the Alarms

The *MTS 5* has one fault alarm and two high/low alarms. Hermetically sealed alarms are available. Each alarm relay is a single-pole, double-throw contact set that contains the following contacts:

- Normally Open (NO)
- Armature Contact (A)
- Normally Closed (NC)

Connecting the Fault Alarm

The fault alarm, if enabled, trips when there is one or more of the following faults:

- power failure
- range error
- system reset by the watchdog function.

Note: *The watchdog function is a supervisory circuit that automatically resets the user program in the event of a system program error.*

The fault alarm operates in a *fail-safe* manner. Pins 4 and 5 provide a *"normally closed"* contact. When the *MTS 5* is operating in a non-fault state, the fault alarm relay is energized to keep the contact between pins 4 and 5 open. When a fault occurs, the fault alarm relay is de-energized, so the contact between pins 4 and 5 closes. The contact between pins 5 and 6 (normally open) works in the opposite way: closed during ordinary operation, open when there is a fault.

Make connections to the fault alarm through terminal block TB2 on the back of the *MTS 5*, as shown in Figure 2-5 on page 2-6.

IMPORTANT: *To maintain good contact at each terminal block and to avoid damaging the pins on the connector, pull the connector straight off (not at an angle), make cable connections while the connector is away from the unit, and push the connector straight on (not at an angle) when the wiring is complete.*

Connecting High/Low Alarms A and B

Each of these alarms can be set to trip on a high or low condition. Make the connections to Alarm A and Alarm B relays through the TB2 terminal block on the back of the *MTS 5* as shown in Figure 2-5 on page 2-6.

Chapter 3

Operation & Programming

Powering Up 3-1

Powering Down 3-1

Programming the Instrument 3-2

Using the Keypad 3-2

Entering the User Program 3-3

Exiting the User Program 3-3

Navigating Through the Menus 3-4

The User1 and User2 Menus 3-6

Setting Up the MTS 5 3-9

Using the Alarms 3-13

Using the Recorder Output 3-16

Entering New Probe Calibration Data 3-22

Additional Setup Procedures 3-23

Powering Up

Whenever the power cord is connected to a power source, the *MTS 5* is actually powered up. If the display is blank, the unit is in *"standby"* mode, which means it is powered up but inactive.

IMPORTANT: *For compliance with the European Union's Low Voltage Directive (73/23/EEC), this unit requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the* MTS 5.

To turn on the *MTS 5*, do the following:

1. Connect the power cord to an appropriate power source.
2. Press the [POWER] key on the front panel.

The *MTS 5* displays a sequence of informational screens while it initializes, then displays a dew/frost point measurement screen.

Powering Down

To turn off the *MTS 5*, do the following:

1. If you are in the *MTS 5 User Program*, exit the *User Program* (see page 3-3), and wait until the unit displays a data screen.
2. Press the [POWER] key on the front panel.
3. When the display reads P OFF?, press the [ENTER] key on the front panel.

The *MTS 5* display goes blank and the unit enters *"standby"* mode.

IMPORTANT: *When the unit is in* "standby" *mode, it still is powered on.*

Programming the Instrument

The *MTS 5 User Program* enables the following procedures:

- set up the display, alarms, and recorder output
- test the display, alarms and recorder output
- adjust the recorder output
- enter calibration data, dew/frost point constant offset, etc.

Note: *The* MTS 5 *stops taking measurements while you are in the* User Program.

See the next section for a description of the front panel keypad, or go directly to page 3-3 for instructions on entering the *User Program*.

Using the Keypad

The *MTS 5* front panel, as shown in Figure 3-1 below, contains five keys. Use of the [POWER] key was described on page 3-1, and the other four keys are used for programming the meter:

[ENTER] - moves to next submenu item; confirms changes

[s] - scrolls up; increases numerical values

[t] - scrolls down; decreases numerical values

[ESC] - exits current submenu item; cancels changes

Note: *To make numerical values change more rapidly, hold down the* [s] *or* [t] *key.*

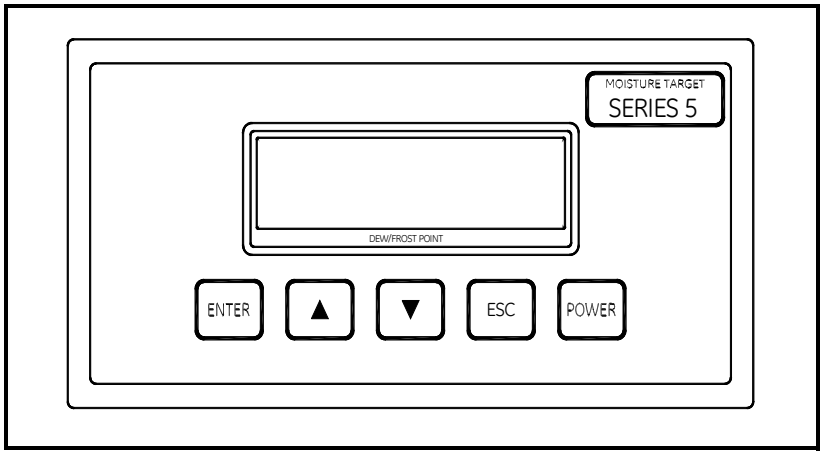


Figure 3-1: Front Panel Keypad

Entering the User Program

To enter the *User Program* while the *MTS 5* is taking measurements, you must press certain keys in the correct order and within a certain length of time. If you do not complete the following instructions exactly, the *MTS 5* returns to taking measurements.

Follow the instructions below, as summarized Table 3-1 below, to enter the *User Program* from normal measurement mode. For a complete programming overview, see Appendix C, *Menu Maps*.

XX.X C	Press [ESC] and wait until ESC appears on the display.

Note: *Perform the following two steps within 5 seconds of the appearance of* ESC *on the display.*

ESC	Press [ENTER] within 5 seconds. Then, press [ESC] within 5 seconds.
AL A	You are now at the *Main Menu*.

Table 3-1: Entering the User Program

Press These Keys:	Display Reads:
[ESC]	ESC
[ENTER] (within 5 seconds)	ESC
[ESC] (within 5 seconds)	AL A (you are in *Main Menu*)

Program and set up specific features of the *MTS 5* according to the instructions in the appropriate sections of this chapter.

Exiting the User Program

To exit the *User Program* at any time:

1. Press [ESC] repeatedly until the display reads run ?.
2. Press [ENTER].

The *MTS 5* then returns to taking measurements.

Navigating Through the Menus

The *MTS 5* User Program is divided into three sections:

- Main menu
- User1 menu
- User2 menu

The contents of these menus is summarized in Table 3-2 below, Table 3-3 on page 3-5 and Table 3-4 on page 3-6. Also, there is a complete map of the *User Program* in Appendix C, *Menu Maps*.

Table 3-2: The Main Menu

Main Menu Item		Submenu Item		Sub-Submenu Item	
AL A (page 3-14)	set up Alarm A	dEG C dEG F H ALA di	°C °F MH disable Alarm A	AL LO AL HI	Low Alarm High Alarm
AL F (page 3-13)	set up Fault Alarm	ALF En ALF di	enable Fault Alarm disable Fault Alarm	N.A.	N.A.
User1 (page 3-7)	enter User1 Menu	X	[enter passcode]	[see Table 3-3 on page 3-5]	
User2 (page 3-8)	enter User2 Menu	X	[enter passcode]	[see Table 3-4 on page 3-6]	
SEtUP (page 3-25)	[Factory Setup]	X	[enter passcode]	N.A.	N.A.

Table 3-3: The User1 Menu

User1 Menu Item		Submenu Item		Sub-Submenu Item	
S_No. (page 3-11)	enter serial number	N.A.	N.A.	N.A.	N.A.
dP (page 3-10)	enter dew point range	dP LO dP HI	enter lowest dew point enter highest dew point	N.A.	N.A.
ProbE (page 3-22)	enter probe calibration curve data	XXX	select dew point value	X.XXXX	enter corresponding MH value
AL b (page 3-14)	set up Alarm B	dEG C dEG F H ALB di	°C °F MH disable Alarm B	AL LO AL HI	Low Alarm High Alarm
rcrd (page 3-16)	set up recorder output	r_unit	select output units	dEG C dEG F H	°C °F MH
		r_out	select output mode and range	0-20 4-20 02	0-20 mA 4-20 mA 0-2 V
		rcd LO	enter output minimum	N.A.	N.A.
		rcd HI	enter output maximum	N.A.	N.A.
uSEr1 (page 3-7)	change User1 passcode	[current passcode displayed]	[enter new passcode]	N.A.	N.A.

Table 3-4: The User2 Menu

User2 Menu Item		Submenu Item		Sub-Submenu Item	
unit (page 3-9)	select display units	dEG C dEG F H	°C °F MH	N.A.	N.A.
OFFSEt (page 3-12)	set dew point offset	0.0	°C	N.A.	N.A.
dEFALT (page 3-24)	reset to factory default settings	SurE	press [ENTER] to default	N.A.	N.A.
tESt (see submenu page references)	test alarms, recorder output, display	t_AL (page 3-15)	test alarm relays	ALA On ALA OF ALb On ALb OF ALF On ALF OF	press [t] to turn alarms on and off
		t_rcd (page 3-18)	test and adjust recorder output	r_out (page 3-19)	test output; select output mode and range, select H=100%, t=50%, L=0%
				rAdJ (page 3-20)	adjust output
		dSPtSt (page 3-23)	test display		
rEF (page 3-24)	calibration references	HrEF LrEF	enter high and low reference values	N.A.	N.A.
bLitE (page 3-11)	set backlight timer			N.A.	N.A.
uSEr1 (page 3-7)	change User1 passcode	[current passcode displayed]	enter new passcode	N.A.	N.A.
uSEr2 (page 3-8)	change User2 passcode	[current passcode displayed]	enter new passcode	N.A.	N.A.

The User1 and User2 Menus

The instructions that follow show how to enter the *User1* menu and the *User2* menu. To prevent tampering with critical parts of the *User Program*, a *passcode* security feature protects the *User1* and *User2* menus (**factory-set default passcodes are 0 for User1 and 1 for User2**). For greatest security, set new passcodes, as described in the following sections.

Entering the User1 Menu

Enter the *MTS 5 User Program* as described on page 3-3:

AL A	Press [s] or [t] until USEr1 appears on the display.
USEr1	Press [ENTER].

Note: *The* MTS 5 *comes from the factory with the* User1 *passcode set to* 0. *If desired, change the passcode as instructed below.*

0	Use the [s] and [t] keys to enter the passcode. Then, press [ENTER].
S_No.	You are now in the *User1* menu.

Changing the User1 Passcode

To change the *User1* passcode, continue as follows:

S_No.	Press [s] or [t] until uSEr1 appears on the display.
uSEr1	Press [ENTER].
XX	Use the [s] and [t] keys to enter a new passcode. Then, press [ENTER] to save the new passcode or press [ESC] to keep the old passcode.
uSEr1	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Entering the User2 Menu

Enter the *MTS 5 User Program* as described on page 3-3:

AL A	Press [s] or [t] until USEr2 appears on the display.
USEr2	Press [ENTER].

Note: *The* MTS 5 *comes from the factory with the* User2 *passcode set to* 1. *If desired, change the passcode as instructed below.*

1	Use the [s] and [t] keys to enter the passcode. Then, press [ENTER].
unit	You are now in the *User2* menu.

Changing the User2 Passcode

To change the *User2* passcode, continue as follows:

unit	Press [s] or [t] until uSEr2 appears on the display.
uSEr2	Press [ENTER].
XX	Use the [s] and [t] keys to enter a new passcode. Then, press [ENTER] to save the new passcode or press [ESC] to keep the old passcode.
uSEr2	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Setting Up the MTS 5

When you turn on the *MTS 5* it begins to display measurements. To program the meter and adapt it to your needs, you can perform the following tasks:

- select the units in which measurements are displayed (page 3-9)
- enter the dew point measurement range (page 3-10)
- set the backlight timer (page 3-11)
- enter the unit's serial number (page 3-11)
- apply a constant dew point measurement offset (page 3-12)

Proceed to the indicated page to perform the desired task.

Selecting the Display Units

The *MTS 5* can display measurements in °C, °F or MH (sensor signal). To select the display units, enter the *User2* menu as described on page 3-8. Then, proceed as follows:

unit	Press [ENTER].
dEG C dEG F H	Press [s] or [t] until the desired units (dEG C, dEG F or H) appears on the display. Then, press [ENTER].
unit	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Setting the High and Low Dew Points

Set the minimum (low) and maximum (high) dew/frost points measured by your unit to suit your specific application needs. To set the dew point measurement range, enter the *User1* menu as described on page 3-7. Then, proceed as follows:

Note: *Find the high and low dew points on the data sheet that came with your unit. Usually the* MTS 5 *is set at the factory for low dew point (dP LO) of -110°C and high dew point (dP HI) of 20°C. You can choose high and low dew point values from -110° to 60°C, in ten-degree increments.*

S_No.	Press [s] or [t] until the dP display appears.
dP	Press [ENTER].
dP HI	Press [ENTER].
XX	Use the [s] and [t] keys to set the desired high (maximum) dew point value. Then, press [ENTER].
dP HI	Press [s] or [t] until the dP LO display appears.
dP LO	Press [ENTER].
XX	Use the [s] and [t] keys to set the desired low (minimum) dew point value. Then, press [ENTER].
dP LO	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Setting the Backlight Timer

If you set the backlight timer to a value greater than zero, the display's backlight comes on whenever you press a key. Then, the backlight stays on for the number of minutes specified in the *User Program* (up to 1,439 minutes). To keep the backlight on all the time, set the backlight timer to 1,440 minutes.

To set the backlight timer, enter the *User2* menu as described on page 3-8. Then, proceed as follows:

unit	Press [s] or [t] until bLitE appears on the display.
bLitE	Press [ENTER].
XX	Use the [s] and [t] keys to set the desired backlight timer interval. Then, press [ENTER].
bLitE	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Entering the Probe Serial Number

To enter the serial number of your probe, enter the *User1* menu as described on page 3-7. Then, proceed as follows:

S_No.	Press [ENTER].
X	Use the [s] and [t] keys to enter the serial number of the probe. Then, press [ENTER].
S_No.	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Applying a Dew Point Offset

To apply a constant offset to all dew point measurements, enter the *User2* menu as described on page 3-8. Then, proceed as follows:

unit	Press [s] or [t] until OFFSEt appears on the display.
OFFSEt	Press [ENTER].
X.X C	Use the [s] and [t] keys to set the desired offset value. Then, press [ENTER] to accept new offset value or press [ESC] to keep the old offset value.
OFFSEt	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Using the Alarms

The standard *MTS 5* is equipped with one fault alarm (AL F) and two high/low alarms (AL A and AL B). To set up and/or test each of these alarms, proceed to the appropriate section.

Setting the Fault Alarm

If enabled, the fault alarm triggers when one of the following events occurs:

- a power failure
- a range error (a reading outside the programmed dew point range)
- reset by the watchdog function

Note: *The watchdog function is a supervisory circuit that automatically resets the* User Program *whenever a system error occurs.*

The fault alarm operates in fail-safe mode. That is, when the meter is in a non-fault state, the fault alarm relay is energized to keep the contact between the normally-closed pins (TB2-4 and TB2-5) open. When a fault occurs, the fault alarm relay is de-energized, so that the contact between pins 4 and 5 closes. [The contact between the normally-open pins (TB2-5 and TB2-6) works in the opposite way: closed during ordinary operation, open when there is a fault.]

To enable or disable the fault alarm, enter the *User Program* as described on page 3-3, and proceed as follows:

AL A	Press [s] or [t] until AL F appears on the display.
AL F	Press [ENTER].
ALF En ALF di	Press [s] or [t] until the enabled or disabled (ALF En or ALF di) option appears on the display. Press [ENTER].
ALF	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Setting the High/Low Alarms

Alarm A is set up in the *Main* menu (see page 3-3), and *Alarm B* is set up in the *User1* menu (see page 3-7). To set up either of the high/low alarms, proceed as follows:

AL A AL b	**Alarm A:** Enter the *Main* menu and press [ENTER] at the AL A screen. **Alarm B:** Enter the *User1* menu. Press [s] or [t] until the AL b screen appears. Then, press [ENTER].
dEG C dEG F H ALX di	Press [s] or [t] until the desired setting (dEG C, dEG F, H or ALX di) appears on the display. [**NOTE:** X = A for Alarm A or X = B for Alarm B.] Then, press [ENTER].

If you disabled the alarm by selecting ALX di above, go directly to the final screen on this page. Otherwise, continue as follows:

Note: *A low (LO) alarm trips when the specified parameter drops below the trip value; a high (HI) alarm trips when the specified parameter goes above the trip value.*

AL LO AL HI	Press [s] or [t] until the desire alarm type (LO or HI) appears on the display. Then, press [ENTER].
XX.X	Use the [s] and [t] keys to set the desired trip point. Then, press [ENTER].
AL A AL b	You are returned to one of these displays. To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Testing the Alarm Relays

To test the alarm relays, enter the *User2* menu as described on page 3-8. Then, proceed as follows:

unit	Press [s] or [t] until tESt appears on the display.
tESt	Press [ENTER].
t_AL	Press [ENTER].

Note: *At the following display, alarms A and B are shown as being tested even if they have been disabled.*

ALA On	Alarm A tripped. Press [t].
ALA OF	Alarm A reset. Press [t].
ALb On	Alarm B tripped. Press [t].
ALb OF	Alarm B reset. Press [t].
ALF On	Alarm F tripped. Press [t].
ALF OF	Alarm F reset. Press [t].

At the above screen, the test modes are cycled through continuously in the order indicated.

ALX ??	To terminate the testing loop at any of the above screens, press [ESC].
t_AL	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Using the Recorder Output

The *MTS 5* is equipped with one recorder output. This output may be configured for 0–20 mA, 4–20 mA, or 0–2 V. In addition, the recorder output may be tested and adjusted. Proceed to the appropriate section for specific instructions.

Setting Up the Recorder Output

Before the recorder output can be used, the following parameters must be programmed:

- units to be recorded
- type (current or voltage) and range of output
- low end (minimum) of the recorder output range
- high end (maximum) of the recorder output range

To set up the recorder output, enter the *User1* menu as described on page 3-7. Then, complete the following steps in the order indicated:

S_No.	Press [s] or [t] until rcrd appears on the display.
rcrd	Press [ENTER].

Selecting the Units

r_unit r_out rcd LO rcd HI	One of these displays appears. Press [s] or [t] until r_unit appears. Then, press [ENTER].
dEG C dEG F H	Press [s] or [t] until the desired units (dEG C, dEG F, or H) appears. Then, press [ENTER].
r_unit	Press [t] until r_out appears.

Selecting the Output Type/ Range

r_out	Press [ENTER].
0-20 4-20 0-2	Press [s] or [t] until the desired output range/type (0-20 mA, 4-20 mA, or 0-2 V) appears. Then, press [ENTER].

IMPORTANT: *Be sure switch S1 on the main PC board is set to the correct output type (current or voltage). See* Connecting the Recorder Output *on page 2-11*.

r_out	Press [t] until rcrd LO appears.

Setting the Output Low Value

rcrd LO	Press [ENTER].

The current recorder output low value, in the units specified on page 3-16, is displayed.

X.X C	Use [s] and [t] to set the desired recorder output low value. Then, press [ENTER].
rcrd LO	Press [t] until rcrd HI appears.

Setting the Output High Value

rcrd HI	Press [ENTER].

The current recorder output high value, in the units specified on page 3-16, is displayed.

X.X C	Use [s] and [t] to set the desired recorder output high value. Then, press [ENTER].
rcrd HI	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Testing and Adjusting the Recorder Output

After you have set up the recorder output as described in the previous section, the output may be tested and/or adjusted as necessary.

IMPORTANT: *Be sure switch S1 on the main PC board is set to the correct output type (current or voltage). See* Connecting the Recorder Output *on page 2-11*.

To measure the recorder output signal, use a digital multimeter that can measure 0–20 mA at a resolution of ±0.01 mA or 0–2 V at a resolution of –0.0001 V. Connect the meter in parallel with the two recorder connections for a voltage measurement or in series with either of the recorder connections for a current measurement.

Testing the Recorder Output

To test the recorder output, enter the *User2* menu as described on page 3-8. Then, proceed as follows:

unit	Press [s] or [t] until tESt appears on the display.
tESt	Press [ENTER].

Testing the Recorder Output (cont.)

t_AL	Press [s] or [t] until t_rcd appears on the display.
t_rcd	Press [ENTER].
r_out rADJ	One of these displays appears. Press [s] or [t] until r_out appears. Then, press [ENTER].
0-20 4-20 0-2	One of these displays appears. Press [s] or [t] until the desired output range/type (0-20 mA, 4-20 mA, or 0-2 V) is displayed. Then, press [ENTER].
X - X H X - X t X - X L	One of these displays appears. Press [s] or [t] until the desired test point (see table 3-5 below) is displayed. Then, press [ENTER].

Table 3-5: Recorder Output Test Points

Output Range	Test Point	Desired Output
0–20 mA	H = 100%	20 mA
	t = 50%	10 mA
	L = ~ 0%	~ 0 mA
4–20 mA	H = 100%	20 mA
	t = 50%	12 mA
	L = 0%	4 mA
0–2 V	H = 100%	2 V
	t = 50%	1 V
	L = ~ 0%	~ 0 V

Testing the Recorder Output (cont.)

The *MTS 5* produces the selected test signal at the recorder output terminals. Use the digital multimeter to measure the test signal. Note the difference, if any, between the measured recorder output reading and the desired recorder output reading.

X - X H
X - X t
X - X L

If desired, press [s] or [t] to select another test point. Then, press [ENTER]. When the testing is complete, press [ESC].

X-XX

When the range selection screen reappears, press [ESC].

r_out

To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Adjusting the Recorder Output

If the recorder output testing performed in the previous section indicates the need for an adjustment, continue the programming from the screen above as follows:

r_out

Press [s] or [t] until rADJ appears. Then, press [ENTER].

Note: *Only the high end reading of the recorder output range can be adjusted; the low end of the range is not adjustable.*

XX

The current adjustment value is displayed. Press [s] or [t] enter an adjustment value from -100 to +100. Then, press [ENTER].

To determine the adjustment value needed to make the 100% test reading match the desired high reading, see the sample calculation on page 3-21.

Adjusting the Recorder Output (cont.)

Each recorder output adjustment unit equals 0.005 mA (or 0.0005 V). As an example, assume that the 100% test output produced a reading of 20.2 mA for a recorder output range of 4–20 mA. Then, the required output adjustment would be calculated as follows:

$$\text{Adjustment} = \frac{20\ \text{mA} - 20.2\ \text{mA}}{0.005\ \text{mA/Unit}} = -40\ \text{Units} \qquad (3\text{-}1)$$

Enter the calculated adjustment at the previous display (page 3-20).

rADJ

Press [s] or [t] until r-out appears. Then, press [ENTER].

r_out

Re-test the recorder output, as described on page 3-18.

Continue to test and adjust the recorder output until the output is within the required tolerance. Then, proceed as follows:

Note: *If the recorder output cannot be properly adjusted, contact GE Infrastructure Sensing for assistance.*

rADJ

To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Entering New Probe Calibration Data

Whenever a new or recalibrated probe is installed in the system, the calibration curve for that probe (as supplied with the probe) must be entered into the *MTS 5 User Program*.

IMPORTANT: *Enter a new probe calibration curve only when necessary. Consult GE Infrastructure Sensing for guidance.*

A probe calibration curve consists of 2 to 18 pairs of (dew point temperature, MH) values. [The MH value is the sensor signal at the associated dew point.]

IMPORTANT: *Before entering the calibration curve data, make sure the high and low dew points programmed into the* MTS 5 *match those on the calibration curve (see page 3-10 for instructions).*

To enter the new probe calibration data, enter the *User1* menu as described on page 3-7. Then, complete the following steps:

S_No.	Press [s] or [t] until ProbE appears on the display.
ProbE	Press [ENTER].

The current minimum dew point reading (see page 3-10) is displayed.

XXX	Press [ENTER].

The current MH (sensor signal) value at that dew point is displayed.

X.XXXX	Press [s] or [t] to enter the new MH value corresponding to the specified dew point. Press [ENTER].
XXX	Press [s] or [t] to enter the next dew point value. Press [ENTER].

Note: *Dew point temperatures range from the minimum to the maximum settings, in 10-degree increments.*

Continue entering dew point/MH pairs until you have completed entering all the calibration curve points.

Entering New Probe Calibration Data (cont.)

XXX	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Additional Setup Procedures

In addition to those procedures already discussed, the following programming steps may be performed:

- testing the liquid crystal display (page 3-23)
- restoring the factory default settings (page 3-24)
- entering new high and low reference values (page 3-24)
- changing factory setup information (page 3-25)

Note: *It is not normally necessary or recommended that the factory setup information be changed. Before attempting this, contact GE Infrastructure Sensing for assistance.*

Testing the Display

The liquid crystal display (LCD) may be tested to ensure that all of its segments are working. To perform this task, enter the *User2* menu as described on page 3-8 and proceed as follows:

unit	Press [s] or [t] until tESt appears on the display.
tESt	Press [ENTER].
t_AL	Press [s] or [t] until dSPtSt appears on the display.
tSPtSt	Press [ENTER].
8.8.8.8.8.8.	All LCD segments are lit. To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

If one or more of the LCD segments is defective, contact GE Infrastructure Sensing for assistance. To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Restoring the Default Settings

To restore all settings and data to their factory default values, enter the *User2* menu as described on page 3-8 and proceed as follows:

unit	Press [s] or [t] until dEFALT appears on the display.
dEFALT	Press [ENTER].
SurE?	Press [ENTER] to reset all default values (or [ESC] to keep the existing values).
donE	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Entering High and Low Reference Values

The *MTS 5* is factory-programmed with high and low reference values. However, you may have to enter new reference values if you replace the User Program or make other changes to the meter. Consult the factory for more information.

IMPORTANT: *The high and low reference values relate to the moisture measurement circuitry of the* MTS 5. *They are <u>not</u> the same thing as the high and low dew points (see page 3-10).*

To enter new high and low reference values, enter the *User2* menu as described on page 3-8 and proceed as follows

unit	Press [s] or [t] until rEF appears on the display.
rEF	Press [ENTER].
H rEF	Press [ENTER].

Entering High and Low Reference Values (cont.)

X.XXXX	Press [s] or [t] to enter a new high reference value. Press [ENTER].
H rEF	Press [s] or [t] until L rEF appears on the display. Press [ENTER].
L rEF	Press [ENTER].
X.XXXX	Press [s] or [t] to enter a new low reference value. Press [ENTER].
L rEF	To exit the *User Program*, press [ESC] until run? appears. Then, press [ENTER].

To continue programming the *MTS 5*, proceed to the appropriate section for instructions.

Accessing Factory Setup

Users do not normally need to access the Factory Setup submenu, and a special passcode is required to do so. Never attempt to program this submenu without first contacting GE Infrastructure Sensing for assistance.

Chapter 4

Service and Maintenance

Introduction. 4-1

Common Problems. 4-2

Replacing the User Program 4-4

Replacing/Recalibrating Moisture Probes 4-6

Introduction

The *Moisture Target Series 5* is designed to be maintenance and trouble free. However, because of severe process conditions and other factors, minor problems may occur from time to time. Some of the most common problems and recommended maintenance procedures are discussed in this chapter. If you can not find the information you need in this chapter, please consult GE Infrastructure Sensing for help.

Caution!
Do not attempt to troubleshoot the *MTS 5* beyond the instructions in this chapter. If you do, you may damage the unit and/or void the warranty.

This chapter covers the following topics:

- common problems (page 4-2)
- replacing the *User Program* (page 4-4)
- replacing/recalibrating moisture probes (page 4-6)

Proceed to the appropriate section to perform any of the above tasks.

Common Problems

If the *MTS 5* measurements read too wet or too dry, or if they do not make sense, there may be a problem with either the probe or a process component. Use the descriptions of common problems in Table 4-1 below to troubleshoot and solve such problems.

Table 4-1: Troubleshooting Guide for Common Problems

Symptom	Possible Cause	Response	Action
The accuracy of the moisture sensor is questioned.	There is insufficient time for the system to equilibrate.	Reads too wet during dry down conditions, or too dry in wet up conditions.	Change the flow rate. A change in dew point indicates the sample system is not at equilibrium, or there is a leak. Allow sufficient time for sample system to equilibrate and moisture reading to become steady. Check for leaks.
	Dew point at the sampling point is different from the dew point of the main stream.	Reads too wet or too dry.	Readings may be correct if the sampling point and main stream do not run under the same process conditions. The different process conditions cause readings to vary. Refer to *Appendix A*, page A-3, for more information. If sampling point and main stream conditions are the same, check sample system pipes, and any pipe between the sample system and main stream for leaks. Also, check sample system for adsorbing water surfaces, such as rubber or plastic tubing, paper-type filters, or condensed water traps. Remove or replace the contaminating parts with stainless steel parts.
	Sensor or sensor shield is affected by process contaminants (see *Appendix A*, pages A-6 and A-7).	Reads too wet or too dry.	Clean the sensor and the sensor shield as described in *Appendix A*, page A-8. Then reinstall the sensor.
	Sensor is contaminated with conductive particles (see *Appendix A*, page A-7).	Reads high dew point.	Clean the sensor and the sensor shield as described in *Appendix A*, page A-8. Then reinstall the sensor. Also, install a proper filter (i.e. sintered or coalescing element).
	Sensor is corroded (see *Appendix A*, page A-7).	Reads too wet or too dry.	Return the probe to factory for evaluation.
	Sensor temperature is greater than 70°C (158°F).	Reads too dry.	Return the probe to factory for evaluation.
	Stream particles causing abrasion.	Reads too wet or too dry	Return the probe to factory for evaluation.

Table 4-1: Troubleshooting Guide for Common Problems (cont.)

Symptom	Possible Cause	Response	Action
A blinking *E* on the left side of the display. Screen always reads the wettest (highest) programmed moisture calibration value while displaying dew/frost point.	Probe is saturated. Liquid water is present on the sensor surface and/ or across electrical connections.	N.A.	Clean the probe as described in *Appendix A,* page A-8. Then reinstall the sensor.
	There is a shorted circuit in the sensor.	N.A.	Run “dry gas” over the sensor surface. If high reading persists, the probe is probably shorted and should be returned to the factory for evaluation.
	Sensor is contaminated with conductive particles (see *Appendix A*, page A-7).	N.A.	Clean the probe as described in *Appendix A,* page A-8. Then reinstall the sensor.
	Improper cable connection.	N.A.	Check the cable connections to both the probe and the hygrometer.
A blinking *E* on the left side of the display. Screen always reads the driest (lowest) programmed moisture calibration value while displaying dew/frost point.	Open circuit in sensor.	N.A.	Return the probe to the factory for evaluation.
	Non-conductive material is trapped under contact arm of sensor.	N.A.	Clean the probe as described in *Appendix A,* page A-8. Then reinstall the sensor. If the low reading persists, return the probe to the factory for evaluation.
	Improper cable connection.	N.A.	Check the cable connections to both the probe and the hygrometer.
Response is slow.	Slow outgassing of system.	N.A.	Replace the system components with stainless steel or electro-polished stainless steel.
	The sensor is contaminated with non-conductive particles (see *Appendix A,* page A-6).	N.A.	Clean the probe as described in *Appendix A,* page A-8. Then reinstall the sensor.

Replacing the User Program

The *User Program* is stored on a PROM (Programmable Read Only Memory) chip. This chip is installed in a socket on the main PC (printed circuit) board located inside the *MTS 5* electronics enclosure. To replace the PROM chip, complete the following steps:

Removing the Main PC Board

1. Turn the power off and disconnect the main power source to the instrument.

!WARNING!
You must disconnect the line power before opening the MTS 5 enclosure.

2. Discharge any static electricity from your body by touching a grounded metal object.

Caution!
PROM chips can be damaged by static electricity.

3. Open the MTS 5 enclosure by removing the four screws on the back of the enclosure.

IMPORTANT: *Do not dislodge or disconnect the flexible jumper that connects the display to the main PC board. Remove the board from the enclosure only far enough to replace the PROM chip.*

4. Slowly slide the main PC board from the enclosure by pulling straight back, being careful not to dislodge the flexible jumper.

Replacing the PROM Chip

1. Refer to Figure 4-1 on page 4-5 to locate the PROM chip on the main PC board. The PROM chip socket is labeled as U19.
2. Use a chip puller to remove the PROM chip from its socket.

Caution!
PROM chips can be damaged by static electricity. Observe anti-static precautions before proceeding.

3. Place the new PROM chip in the socket labeled U19, making sure that the beveled corner on the PROM chip matches the beveled corner on the socket (see Figure 4-1 on page 4-5).
4. Gently seat the new PROM chip completely into the socket.

Re-installing the Main PC Board

1. Carefully slide the main PC board back into the enclosure.
2. Replace the back panel on the enclosure and reinstall the four screws. Do not overtighten the screws.

Checking the New User Program

1. Power up the *MTS 5* (see page 3-1).
2. Check to make sure the calibration and reference data are not corrupted (see Chapter 3, *Operation & Programming*). If any data is corrupted, re-enter the data as described in Chapter 3.

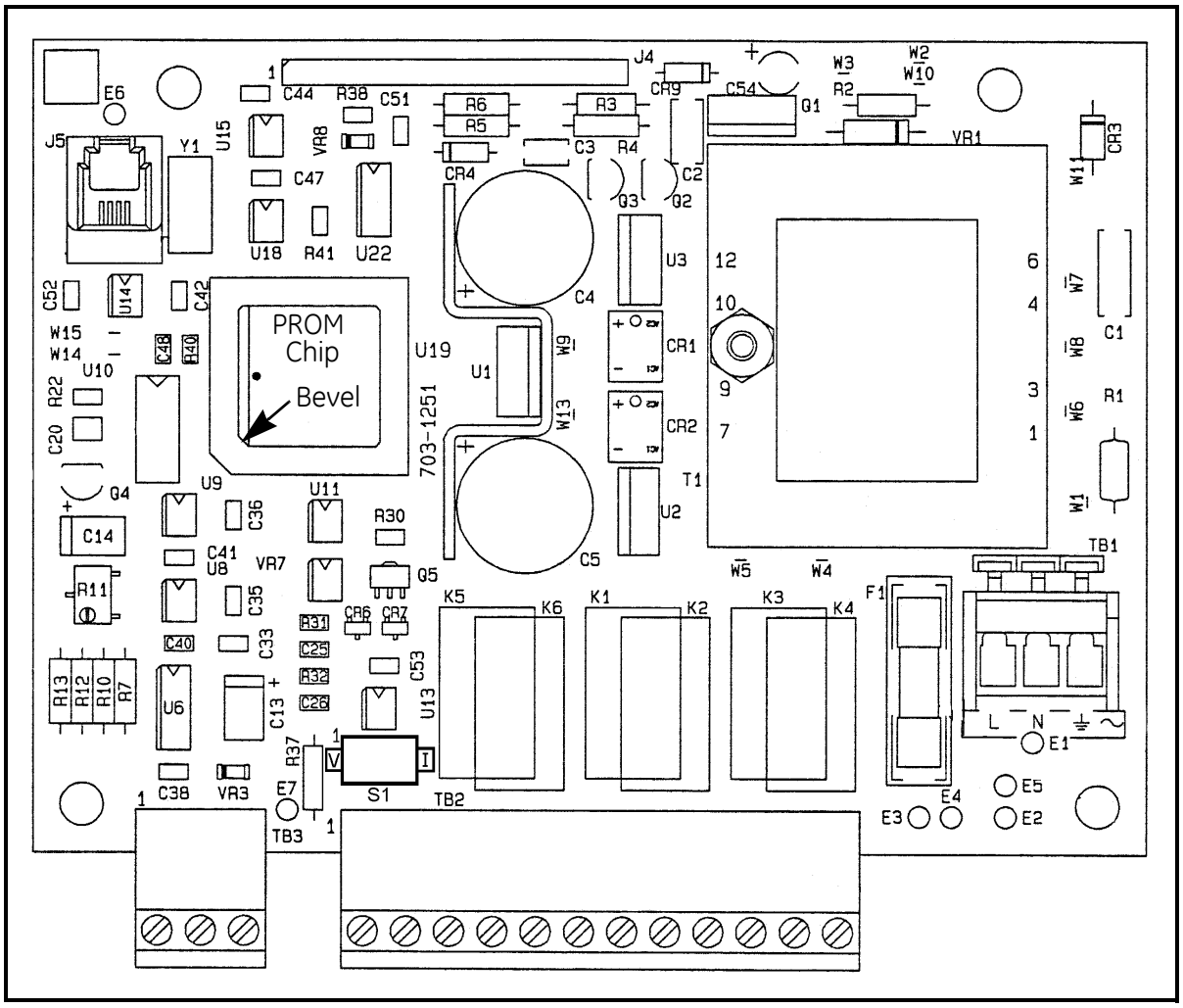


Figure 4-1: PROM Location and Orientation

Replacing/Recalibrating Moisture Probes

For maximum accuracy, moisture probes should be returned to the factory for recalibration every 6–12 months, depending on the application. Under very severe conditions, more frequent calibrations are recommended; under very mild conditions, less frequent calibrations are necessary. Contact a GE Infrastructure Sensing applications engineer for a specific recommended calibration frequency

All new or recalibrated moisture probes must be installed in accordance with the instructions presented in Chapter 2, *Installation*.

IMPORTANT: *To maintain good contact at each terminal block and to avoid damaging the pins on the connector, pull the connector straight off (not at an angle), make cable connections while the connector is away from the unit, and push the connector straight on (not at an angle) when the wiring is complete.*

After the probe has been installed and wired, enter the probe calibration curve data as described on page 3-22. Each probe is shipped with its own *Calibration Data Sheet*, which includes the serial number for that probe.

Chapter 5

Specifications

Electronics 5-1

Moisture Measurement. 5-3

Electronics

Input:

moisture signal from GE Infrastructure Sensing thin-film aluminum oxide moisture sensor

Intrinsic Safety:

external safety barrier for moisture input (optional)

Analog Output:

single, isolated recorder output for dew point, internally optically isolated, 10-bit (0.1%) resolution

0–2 V: 10 kΩ minimum load resistance
0–20 mA: 400 Ω maximum series resistance
4–20 mA: 400 Ω maximum series resistance

Outputs are user-programmable within the range of the instrument and the corresponding probe.

Alarm Relays:

1 fault alarm and 2 programmable high/low alarms:

Form C SPDT Relays	Standard	Hermetically Sealed
	8A @ 250VAC	0.3A @ 115VAC
	8A @ 30VDC	2A @ 28VDC

Standard and hermetically-sealed designs are available for the high/low alarms, set to trip at any level within the range of the instrument, programmable from the front panel. (The fault alarm is the same type as the high/low alarms.)

Note: *To maintain Low Voltage Directive Compliance, EN Standard EN61010, the following rating applies: 2A @ 28VDC*

Alarm Setpoint Repeatability:

±0.1°C dew point

Configurations:

panel-mount, bench-mount, PC board

Display:

1-line, 6-digit Liquid Crystal Display (LCD) with programmable backlight

Front Panel:

weatherproof membrane front panel display/keypad meets NEMA-4 and IP66 requirements (panel-mount version only)

Electronics (cont.)

Display Functions:

dew point temperature °C, °F, MH

Input Power:

100/120/230/240 VAC, 50/60 Hz, ±10%
24 VDC

Power Dissipation:

100/120/230/240 VAC units: 10 VA maximum
24 VDC units: 10 W maximum

Fuse:

100/120 VAC units: 5 mm x 20 mm, Type T, 0.125 A, 250 V
230/240 VAC units: 5 mm x 20 mm, Type T, 0.125 A, 250 V
24 VDC units: 5 mm x 20 mm, Type T, 0.4 A, 250 V

Temperature:

operating: 0° to 60°C
storage: -30° to 70°C

Warm-Up Time:

meets specified accuracy within three minutes

Dimensions:

panel-mount: 2.83 x 5.67 x 4.71 in. (H x W x D)
(71.9 x 144 x 119.6 mm)
cutout required: 2.65 x 5.4 in. (H x W) (67.3 x 137.2 mm)

bench-mount: 4.11 x 6.42 x 4.71 in. (H x W x D)
(104.4 x 144 x 119.6 mm)

board-mount: 8.00 x 5.50 x 2.53 in. (H x W x D)
(203.2 x 139.7 x 64.2 mm)

European Compliance:

complies with EMC Directive 89/336/EEC and 73/23/EEC Low Voltage Directive (Installation Category II, Pollution Degree II)

Note: *The mains cord installation must comply with European Standard EN61010 to maintain Low Voltage Directive compliance.*

Moisture Measurement

Sensor Type:

thin-film aluminum oxide moisture sensor probe

Moisture Probe Compatibility:

compatible with all GE Infrastructure Sensing M-Series aluminum oxide moisture probes

Probe Cable Length:

2,000 ft (600 m) maximum

Moisture Probe Pressure Rating:

M1: 5 microns Hg to 75 psig
M2: 5 microns Hg to 5,000 psig

Dew/Frost Point Temperature:

Overall Calibration Range:
-110° to 60°C

Available Calibration Range Options:
Standard: -80° to 20°C with data to -110°C
Extended High: -80° to 60°C with data to -110°C

Accuracy:
±2°C from -65° to 60°C
±3°C from -110° to -66°C

Repeatability:
±0.5°C from -65° to 60°C
±1.0°C from -110° to -66°C

Appendix A

Application of the Hygrometer

Introduction. A-1

Moisture Monitor Hints A-2

Contaminants A-6

Aluminum Oxide Probe Maintenance A-8

Corrosive Gases And Liquids A-11

Materials of Construction. A-12

Calculations and Useful Formulas in Gas Applications A-13

Liquid Applications. A-23

Empirical Calibrations. A-30

Solids Applications. A-35

Introduction

This appendix contains general information about moisture monitoring techniques. System contaminants, moisture probe maintenance, process applications and other considerations for ensuring accurate moisture measurements are discussed.

The following specific topics are covered:

- Moisture Monitor Hints
- Contaminants
- Aluminum Oxide Probe Maintenance
- Corrosive Gases and Liquids
- Materials of Construction
- Calculations and Useful Formulas in Gas Applications
- Liquid Applications
- Empirical Calibrations
- Solids Applications

Moisture Monitor Hints

GE Infrastructure Sensing hygrometers, using aluminum oxide moisture probes, have been designed to reliably measure the moisture content of both gases and liquids. The measured dew point will be the real dew point of the system at the measurement location and at the time of measurement. However, no moisture sensor can determine the origin of the measured moisture content. In addition to the moisture content of the fluid to be analyzed, the water vapor pressure at the measurement location may include components from sources such as: moisture from the inner walls of the piping; external moisture through leaks in the piping system; and trapped moisture from fittings, valves, filters, etc. Although these sources may cause the measured dew point to be higher than expected, it is the actual dew point of the system at the time of measurement.

One of the major advantages of the GE Infrastructure Sensing hygrometer is that it can be used for *in situ* measurements (i.e. the sensor element is designed for installation directly within the region to be measured). As a result, the need for complex sample systems that include extensive piping, manifolds, gas flow regulators and pressure regulators is eliminated or greatly reduced. Instead, a simple sample system to reduce the fluid temperature, filter contaminants and facilitate sensor removal is all that is needed.

Whether the sensor is installed in situ or in a remote sampling system, the accuracy and speed of measurement depend on the piping system and the dynamics of the fluid flow. Response times and measurement values will be affected by the degree of equilibrium reached within system. Factors such as gas pressure, flow rate, materials of construction, length and diameter of piping, etc. will greatly influence the measured moisture levels and the response times.

Assuming that all secondary sources of moisture have been eliminated and the sample system has been allowed to come to equilibrium, then the measured dew point will equal the actual dew point of the process fluid.

Some of the most frequently encountered problems associated with moisture monitoring sample systems include:

- the moisture content value changes as the total gas pressure changes
- the measurement response time is very slow
- the dew point changes as the fluid temperature changes
- the dew point changes as the fluid flow rate changes.

Moisture Monitor Hints (cont.)

GE Infrastructure Sensing hygrometers measure only water vapor pressure. In addition, the instrument has a very rapid response time and it is not affected by changes in fluid flow rate. If any of the above situations occur, then they are almost always caused by a defect in the sample system. The moisture sensor itself cannot lead to such problems.

Pressure

GE Infrastructure Sensing hygrometers can accurately measure dew points under pressure conditions ranging from vacuums as low as a few microns of mercury up to pressures of 5000 psig. The calibration data supplied with the moisture probe is directly applicable over this entire pressure range, without correction.

Note: *Although the moisture probe calibration data is supplied as meter reading vs. dew point, it is important to remember that the moisture probe responds only to water vapor pressure.*

When a gas is compressed, the partial pressures of all the gaseous components are proportionally increased. Conversely, when a gas expands, the partial pressures of the gaseous components are proportionally decreased. Therefore, increasing the pressure on a closed aqueous system will increase the vapor pressure of the water, and hence, increase the dew point. This is not just a mathematical artifact. The dew point of a gas with 1000 ppm_v of water at 200 psig will be considerably higher than the dew point of a gas with 1000 ppm_v of water at 1 atm. Gaseous water vapor will actually condense to form liquid water at a higher temperature at the 200 psig pressure than at the 1 atm pressure. Thus, if the moisture probe is exposed to pressure changes, the measured dew point will be altered by the changed vapor pressure of the water.

It is generally advantageous to operate the hygrometer at the highest possible pressure, especially at very low moisture concentrations. This minimizes wall effects and results in higher dew point readings, which increases the sensitivity of the instrument.

Response Time

The response time of the GE Infrastructure Sensing standard M Series Aluminum Oxide Moisture Probe is very rapid - a step change of 63% in moisture concentration will be observed in approximately 5 seconds. Thus, the observed response time to moisture changes is, in general, limited by the response time of the sample system as a whole. Water vapor is absorbed tenaciously by many materials, and a large, complex processing system can take several days to “dry down” from atmospheric moisture levels to dew points of less than -60°C. Even simple systems consisting of a few feet of stainless steel tubing and a small chamber can take an hour or more to dry down from dew points of +5°C to -70°C. The rate at which the system reaches equilibrium will depend on flow rate, temperature, materials of construction and system pressure. Generally speaking, an increase

in flow rate and/or temperature will decrease the response time of the sample system.

Response Time (cont.)

To minimize any adverse affects on response time, the preferred materials of construction for moisture monitoring sample systems are stainless steel, Teflon® and glass. Materials to be avoided include rubber elastomers and related compounds.

Temperature

The GE Infrastructure Sensing hygrometer is largely unaffected by ambient temperature. However, for best results, it is recommended that the ambient temperature be at least 10°C higher than the measured dew point, up to a maximum of 70°C. Because an ambient temperature increase may cause water vapor to be desorbed from the walls of the sample system, it is possible to observe a diurnal change in moisture concentration for a system exposed to varying ambient conditions. In the heat of the day, the sample system walls will be warmed by the ambient air and an off-gassing of moisture into the process fluid, with a corresponding increase in measured moisture content, will occur. The converse will happen during the cooler evening hours.

Flow Rate

GE Infrastructure Sensing hygrometers are unaffected by the fluid flow rate. The moisture probe is not a mass sensor but responds only to water vapor pressure. The moisture probe will operate accurately under both static and dynamic fluid flow conditions. In fact, the specified maximum fluid linear velocities (see Table A-1 and Table A-2 on page A-5) for the M Series Aluminum Oxide Moisture Probe indicate a mechanical stability limitation rather than a sensitivity to the fluid flow rate.

If the measured dew point of a system changes with the fluid flow rate, then it can be assumed that off-gassing or a leak in the sample system is causing the variation. If secondary moisture is entering the process fluid (either from an ambient air leak or the release of previously absorbed moisture from the sample system walls), an increase in the flow rate of the process fluid will dilute the secondary moisture source. As a result, the vapor pressure will be lowered and a lower dew point will be measured.

Note: *Refer to the* Specifications *chapter in the Hygrometer User's Manual for the maximum allowable flow rate for the instrument.*

Flow Rate (cont.)

Table A-1: Maximum Gas Flow Rates

Based on the physical characteristics of air at a temperature of 77°F and a pressure of 1 atm, the following flow rates will produce the maximum allowable gas stream linear velocity of 10,000 cm/sec in the corresponding pipe sizes.

Inside Pipe Diameter (in.)	Gas Flow Rate (cfm)
0.25	7
0.50	27
0.75	60
1.0	107
2.0	429
3.0	966
4.0	1,718
5.0	2,684
6.0	3,865
7.0	5,261
8.0	6,871
9.0	8,697
10.0	10,737
11.0	12,991
12.0	15,461

Table A-2: Maximum Liquid Flow Rates

Based on the physical characteristics of benzene at a temperature of 77°F, the following flow rates will produce the maximum allowable fluid linear velocity of 10 cm/sec in the corresponding pipe sizes.

Inside Pipe Diameter (in.)	Flow Rate	
	(gal/hr)	(l/hr)
0.25	3	11
0.50	12	46
0.75	27	103
1.0	48	182
2.0	193	730
3.0	434	1,642
4.0	771	2,919
5.0	1,205	4,561
6.0	1,735	6,567
7.0	2,361	8,939
8.0	3,084	11,675
9.0	3,903	14,776
10.0	4,819	18,243
11.0	5,831	22,074
12.0	6,939	26,269

Contaminants

Industrial gases and liquids often contain fine particulate matter. Particulates of the following types are commonly found in such process fluids:

- carbon particles
- salts
- rust particles
- polymerized substances
- organic liquid droplets
- dust particles
- molecular sieve particles
- alumina dust

For convenience, the above particulates have been divided into three broad categories. Refer to the appropriate section for a discussion of their affect on the GE Infrastructure Sensing moisture probe.

Non-Conductive Particulates

Note: *Molecular sieve particles, organic liquid droplets and oil droplets are typical of this category.*

In general, the performance of the moisture probe will not be seriously hindered by the condensation of non-conductive, non-corrosive liquids. However, a slower response to moisture changes will probably be observed, because the contaminating liquid barrier will decrease the rate of transport of the water vapor to the sensor and reduce its response time.

Particulate matter with a high density and/or a high flow rate may cause abrasion or pitting of the sensor surface. This can drastically alter the calibration of the moisture probe and, in extreme cases, cause moisture probe failure. A stainless steel shield is supplied with the moisture probe to minimize this effect, but in severe cases, it is advisable to install a Teflon® or stainless steel filter in the fluid stream.

On rare occasions, non-conductive particulate material may become lodged under the contact arm of the sensor, creating an open circuit. If this condition is suspected, refer to *Aluminum Oxide Probe Maintenance* on page A-8 and *Cleaning the Moisture Probe* on page A-9, for the recommended cleaning procedure.

Conductive Particulates

Note: *Metallic particles, carbon particles and conductive liquid droplets are typical of this category.*

Since the hygrometer reading is inversely proportional to the impedance of the sensor, a decrease in sensor impedance will cause an increase in the meter reading. Thus, trapped conductive particles across the sensor leads or on the sensor surface, which will decrease the sensor impedance, will cause an erroneously high dew point reading. The most common particulates of this type are carbon (from furnaces), iron scale (from pipe walls) and glycol droplets (from glycol-based dehydrators).

If the system contains conductive particulates, it is advisable to install a Teflon® or stainless steel filter in the fluid stream.

Corrosive Particulates

Note: *Sodium chloride and sodium hydroxide particulates are typical of this category.*

Since the active sensor element is constructed of aluminum, any material that corrodes aluminum will deleteriously affect the operation of the moisture probe. Furthermore, a combination of this type of particulate with water will cause pitting or severe corrosion of the sensor element. In such instances, the sensor cannot be cleaned or repaired and the probe must be replaced.

Obviously, the standard moisture probe cannot be used in such applications unless the complete removal of such particulates by adequate filtration is assured.

Aluminum Oxide Probe Maintenance

As part of a routine preventive maintenance program, the moisture probe should be removed and returned to the factory for recalibration once a year. Between these calibrations, if the aluminum oxide moisture probe becomes contaminated with an electrically conductive liquid, the moisture measurements will be erroneously high. In such a situation, the probe should be removed from the sample system and cleaned as described in *Cleaning the Moisture Probe* on page A-9.

!WARNING!
The probe cleaning procedure should be performed only by a qualified technician or chemist.

IMPORTANT: *Moisture probes must be handled carefully and cannot be cleaned in any fluid which will attack its components. The probe's materials of construction are Al, Al_2O_3, nichrome, gold, stainless steel, glass and Viton® A. Also, the sensor's aluminum sheet is very fragile and can be easily bent or distorted. Do not permit anything to touch it!*

!WARNING!
Make sure you replace the moisture probe before restarting the system

Cleaning the Moisture Probe

To clean the moisture probe, the following items are required:

- approximately 600 ml of reagent grade hexane or toluene, divided into two batches of 300 ml each
- approximately 300 ml of distilled (NOT deionized) water
- three glass (NOT metal) containers to hold the above liquids.

To clean the aluminum oxide moisture probe, complete the following steps:

1. Record the dew point of the ambient air.

IMPORTANT: *To avoid damaging the sensor during the following steps, do not allow the sensor to contact the walls or the bottom of the containers.*

2. Carefully remove the protective shield covering the sensor without touching the exposed sensor (see Figure A-1 on page A-10).
3. Soak the sensor in one of the containers of hexane or toluene for 10 minutes.
4. Remove the sensor from the hexane or toluene and soak it in the container of distilled water for 10 minutes.
5. Remove the sensor from the distilled water and soak it in the second container of (clean) hexane or toluene for 10 minutes.
6. Remove the sensor from the hexane or toluene and place it sensor-side-up in an oven set at 50°C ± 2°C (122°F ± 3.6°F) for 24 hours.
7. Repeat Steps 3-6 to clean the protective shield. To ensure the removal of any contaminants that may have become embedded in the porous walls of the shield, swirl the shield in the solvents during the soaking procedure.
8. Without touching the exposed sensor, carefully reinstall the protective shield over the sensor.
9. Connect the probe cable to the cleaned probe and measure the dew point of the same ambient air recorded in Step 1.
10. If the probe is determined to be in proper calibration (±2°C/ ±3.6°F), it has been successfully cleaned and may be reinstalled in the sample cell.

If the probe is not in proper calibration, proceed to Step 11.

11. Repeat Steps 1-10 using soaking time intervals of 5 times the previous cleaning sequence, until two consecutive cleanings produce identical probe responses to the ambient dew point.

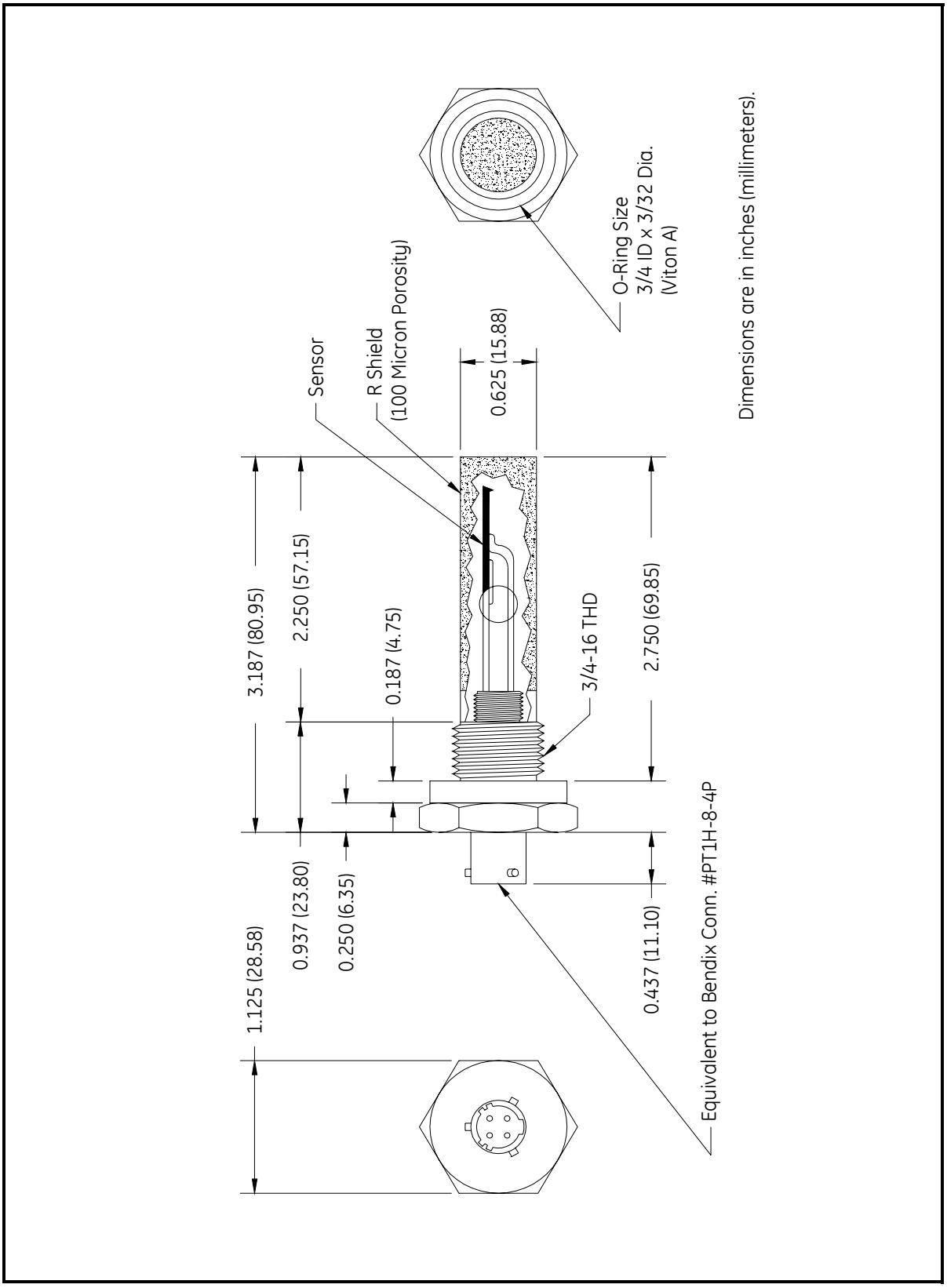


Figure A-1: GE Infrastructure Sensing M Series Moisture Probe

Corrosive Gases And Liquids

GE Infrastructure Sensing M Series Aluminum Oxide Moisture Probes have been designed to minimize the affect of corrosive gases and liquids. As indicated in *Materials of Construction* on page A-12, no copper, solder or epoxy is used in the construction of these probes. The moisture content of corrosive gases such as H_2S, SO_2, cyanide containing gases, acetic acid vapors, etc. can be measured directly.

IMPORTANT: *Since the active sensor is aluminum, any fluid which corrodes aluminum will affect the sensor's performance.*

By observing the following precautions, the moisture probe may be used successfully and reliably:

1. The moisture content of the corrosive fluid must be 10 ppm_v or less at 1 atmosphere, or the concentration of the corrosive fluid must be 10 ppm_v or less at 1 atmosphere.
2. The sample system must be pre-dried with a dry inert gas, such as nitrogen or argon, prior to introduction of the fluid stream. Any adsorbed atmospheric moisture on the sensor will react with the corrosive fluid to cause pitting or corrosion of the sensor.
3. The sample system must be purged with a dry inert gas, such as nitrogen or argon, prior to removal of the moisture probe. Any adsorbed corrosive fluid on the sensor will react with ambient moisture to cause pitting or corrosion of the sensor.
4. Operate the sample system at the lowest possible gas pressure.

Using the precautions listed above, the moisture probe may be used to successfully measure the moisture content in such fluids as hydrochloric acid, sulfur dioxide, chlorine and bromine.

Materials of Construction

M1 and M2 Probes:

Sensor Element:	99.99% aluminum, aluminum oxide, gold, Nichrome A6
Back Wire:	316 stainless steel
Contact Wire:	gold, 304 stainless steel
Front Wire:	316 stainless steel
Support:	Corning 9010 glass
Shell	303 stainless steel
Shield	304 stainless steel
O-Ring	Vitron®

Electrical Connector:

Pins:	302 Stainless Steel
Glass:	Corning 9010
O-Ring:	silicone rubber

Calculations and Useful Formulas in Gas Applications

A knowledge of the dew point of a system enables one to calculate all other moisture measurement parameters. The most important fact to recognize is that *for a particular dew point there is one and only one equivalent vapor pressure*.

IMPORTANT: *The calibration of GE Infrastructure Sensing moisture probes is based on the vapor pressure of liquid water above 0°C and frost below 0°C. GE Infrastructure Sensing moisture probes are never calibrated with supercooled water.*

Caution is advised when comparing dew points measured with a GE Infrastructure Sensing hygrometer to those measured with a mirror type hygrometer, since such instruments may provide the dew points of supercooled water.

As stated above, the dew/frost point of a system defines a unique partial pressure of water vapor in the gas. Table 3 on page 18, which lists water vapor pressure as a function of dew point, can be used to find either the saturation water vapor pressure at a known temperature or the water vapor pressure at a specified dew point. In addition, all definitions involving *humidity* can then be expressed in terms of the water vapor pressure.

Nomenclature

The following symbols and units are used in the equations that are presented in the next few sections:

- RH = relative humidity
- T_K = temperature (°K = °C + 273)
- T_R = temperature (°R = °F + 460)
- ppm_v = parts per million by volume
- ppm_w = parts per million by weight
- M_w = molecular weight of water (18)
- M_T = molecular weight of carrier gas
- P_S = saturation vapor pressure of water at the prevailing temperature (mm of Hg)
- P_W = water vapor pressure at the measured dew point (mm of Hg)
- P_T = total system pressure (mm of Hg)

Parts per Million by Volume

The water concentration in a system, in parts per million by volume, is proportional to the ratio of the water vapor partial pressure to the total system pressure:

$$ppm_v = \frac{P_W}{P_T} \times 10^6 \qquad \text{(A-1)}$$

In a closed system, increasing the total pressure of the gas will proportionally increase the partial pressures of the various components. The relationship between dew point, total pressure and ppm_v is provided in nomographic form in Figure A-2 on page A-15.

Note: *The nomograph shown in Figure A-2 is applicable only to gases. Do not apply it to liquids.*

To compute the moisture content for any ideal gas at a given pressure, refer to Figure A-2 on page A-15. Using a straightedge, connect the dew point (as measured with the GE Infrastructure Sensing Hygrometer) with the known system pressure. Read the moisture content in ppm_v where the straightedge crosses the moisture content scale.

Typical Problems

1. Find the water content in a nitrogen gas stream, if a dew point of -20°C is measured and the pressure is 60 psig.

   Solution: In Figure A-2 on page A-15, connect 60 psig on the Pressure scale with -20°C on the Dew/Frost Point scale. Read **200 ppm_v,** on the Moisture Content scale.

2. Find the expected dew/frost point for a helium gas stream having a measured moisture content of 1000 ppm_v and a system pressure of 0.52 atm.

   Solution: In Figure A-2 on page A-15, connect 1000 ppm_v on the Moisture Content scale with 0.52 atm on the Pressure scale. Read the expected frost point of **–27°C** on the Dew/Frost Point scale.

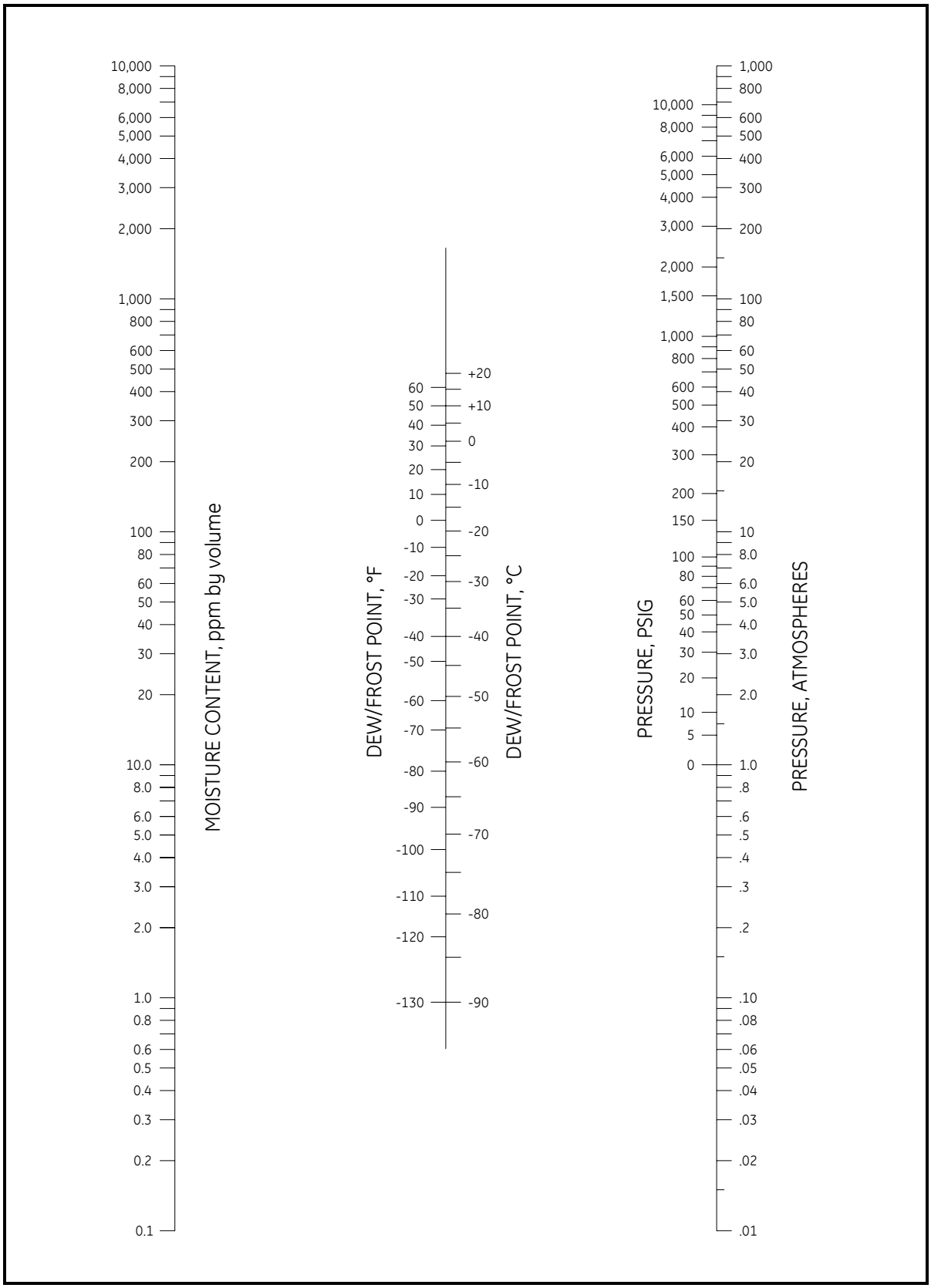


Figure A-2: Moisture Content Nomograph for Gases

Parts per Million by Weight

The water concentration in the gas phase of a system, in parts per million by weight, can be calculated directly from the ppm_v and the ratio of the molecular weight of water to that of the carrier gas as follows:

$$ppm_w = ppm_v \times \frac{M_W}{M_T} \quad (1\text{-}2)$$

Relative Humidity

Relative humidity is defined as the ratio of the actual water vapor pressure to the saturation water vapor pressure at the prevailing ambient temperature, expressed as a percentage.

$$RH = \frac{P_W}{P_S} \times 100 \quad (1\text{-}3)$$

Typical Problem

Find the relative humidity in a system, if the measured dew point is 0°C and the ambient temperature is +20°C.

Solution: From Table A-3 on page A-18, the water vapor pressure at a dew point of 0°C is 4.579 mm of Hg and the saturation water vapor pressure at an ambient temperature of +20°C is 17.535 mm of Hg. Therefore, the relative humidity of the system is
100 x 4.579/17.535 = **26.1%**.

Weight of Water per Unit Volume of Carrier Gas

Three units of measure are commonly used in the gas industry to express the weight of water per unit volume of carrier gas. They all represent a vapor density and are derivable from the vapor pressure of water and the Perfect Gas Laws. Referenced to a temperature of 60°F and a pressure of 14.7 psia, the following equations may be used to calculate these units:

$$\frac{\text{mg of water}}{\text{liter of gas}} = 289 \times \frac{P_W}{T_K} \quad (1\text{-}4)$$

$$\frac{\text{lb of water}}{\text{ft}^3 \text{ of gas}} = 0.0324 \times \frac{P_W}{T_R} \quad (1\text{-}5)$$

$$\frac{\text{lb of water}}{\text{MMSCF of gas}} = \frac{ppm_v}{21.1} = \frac{10^6 \times P_W}{21.1 \times P_T} \quad (1\text{-}6)$$

Note: *MMSCF is an abbreviation for a "million standard cubic feet" of carrier gas.*

Weight of Water per Unit Weight of Carrier Gas

Occasionally, the moisture content of a gas is expressed in terms of the weight of water per unit weight of carrier gas. In such a case, the unit of measure defined by the following equation is the most commonly used:

$$\frac{\text{grains of water}}{\text{lb of gas}} = 7000 \times \frac{M_W \times P_W}{M_T \times P_T} \qquad (1\text{-}7)$$

For ambient air at 1 atm of pressure, the above equation reduces to the following:

$$\frac{\text{grains of water}}{\text{lb of gas}} = 5.72 \times P_W \qquad (1\text{-}8)$$

Table A-3: Vapor Pressure of Water

Note: *If the dew/frost point is known, the table will yield the partial water vapor pressure (P_W) in mm of Hg. If the ambient or actual gas temperature is known, the table will yield the saturated water vapor pressure (P_S) in mm of Hg.*

Water Vapor Pressure Over Ice

Temp. (°C)	0	2	4	6	8
-90	0.000070	0.000048	0.000033	0.000022	0.000015
-80	0.000400	0.000290	0.000200	0.000140	0.000100
-70	0.001940	0.001430	0.001050	0.000770	0.000560
-60	0.008080	0.006140	0.004640	0.003490	0.002610
-50	0.029550	0.023000	0.017800	0.013800	0.010600
-40	0.096600	0.076800	0.060900	0.048100	0.037800
-30	0.285900	0.231800	0.187300	0.150700	0.120900

Temp. (°C)	0.0	0.2	0.4	0.6	0.8
-29	0.317	0.311	0.304	0.298	0.292
-28	0.351	0.344	0.337	0.330	0.324
-27	0.389	0.381	0.374	0.366	0.359
-26	0.430	0.422	0.414	0.405	0.397
-25	0.476	0.467	0.457	0.448	0.439
-24	0.526	0.515	0.505	0.495	0.486
-23	0.580	0.569	0.558	0.547	0.536
-22	0.640	0.627	0.615	0.603	0.592
-21	0.705	0.691	0.678	0.665	0.652
-20	0.776	0.761	0.747	0.733	0.719
-19	0.854	0.838	0.822	0.806	0.791
-18	0.939	0.921	0.904	0.887	0.870
-17	1.031	1.012	0.993	0.975	0.956
-16	1.132	1.111	1.091	1.070	1.051
-15	1.241	1.219	1.196	1.175	1.153
-14	1.361	1.336	1.312	1.288	1.264
-13	1.490	1.464	1.437	1.411	1.386
-12	1.632	1.602	1.574	1.546	1.518
-11	1.785	1.753	1.722	1.691	1.661
-10	1.950	1.916	1.883	1.849	1.817
-9	2.131	2.093	2.057	2.021	1.985
-8	2.326	2.285	2.246	2.207	2.168
-7	2.537	2.493	2.450	2.408	2.367
-6	2.765	2.718	2.672	2.626	2.581
-5	3.013	2.962	2.912	2.862	2.813
-4	3.280	3.225	3.171	3.117	3.065
-3	3.568	3.509	3.451	3.393	3.336
-2	3.880	3.816	3.753	3.691	3.630
-1	4.217	4.147	4.079	4.012	3.946
0	4.579	4.504	4.431	4.359	4.287

Table A-3: Vapor Pressure of Water (Continued)

Aqueous Vapor Pressure Over Water					
Temp. (°C)	0.0	0.2	0.4	0.6	0.8
0	4.579	4.647	4.715	4.785	4.855
1	4.926	4.998	5.070	5.144	5.219
2	5.294	5.370	5.447	5.525	5.605
3	5.685	5.766	5.848	5.931	6.015
4	6.101	6.187	6.274	6.363	6.453
5	6.543	6.635	6.728	6.822	6.917
6	7.013	7.111	7.209	7.309	7.411
7	7.513	7.617	7.722	7.828	7.936
8	8.045	8.155	8.267	8.380	8.494
9	8.609	8.727	8.845	8.965	9.086
10	9.209	9.333	9.458	9.585	9.714
11	9.844	9.976	10.109	10.244	10.380
12	10.518	10.658	10.799	10.941	11.085
13	11.231	11.379	11.528	11.680	11.833
14	11.987	12.144	12.302	12.462	12.624
15	12.788	12.953	13.121	13.290	13.461
16	13.634	13.809	13.987	14.166	14.347
17	14.530	14.715	14.903	15.092	15.284
18	15.477	15.673	15.871	16.071	16.272
19	16.477	16.685	16.894	17.105	17.319
20	17.535	17.753	17.974	18.197	18.422
21	18.650	18.880	19.113	19.349	19.587
22	19.827	20.070	20.316	20.565	20.815
23	21.068	21.324	21.583	21.845	22.110
24	22.377	22.648	22.922	23.198	23.476
25	23.756	24.039	24.326	24.617	24.912
26	25.209	25.509	25.812	26.117	26.426
27	26.739	27.055	27.374	27.696	28.021
28	28.349	28.680	29.015	29.354	29.697
29	30.043	30.392	30.745	31.102	31.461
30	31.824	32.191	32.561	32.934	33.312
31	33.695	34.082	34.471	34.864	35.261
32	35.663	36.068	36.477	36.891	37.308
33	37.729	38.155	38.584	39.018	39.457
34	39.898	40.344	40.796	41.251	41.710
35	42.175	42.644	43.117	43.595	44.078
36	44.563	45.054	45.549	46.050	46.556
37	47.067	47.582	48.102	48.627	49.157
38	49.692	50.231	50.774	51.323	51.879
39	52.442	53.009	53.580	54.156	54.737
40	55.324	55.910	56.510	57.110	57.720
41	58.340	58.960	59.580	60.220	60.860

Table A-3: Vapor Pressure of Water (Continued)

Aqueous Vapor Pressure Over Water (cont.)					
Temp. (°C)	0.0	0.2	0.4	0.6	0.8
42	61.500	62.140	62.800	63.460	64.120
43	64.800	65.480	66.160	66.860	67.560
44	68.260	68.970	69.690	70.410	71.140
45	71.880	72.620	73.360	74.120	74.880
46	75.650	76.430	77.210	78.000	78.800
47	79.600	80.410	81.230	82.050	82.870
48	83.710	84.560	85.420	86.280	87.140
49	88.020	88.900	89.790	90.690	91.590
50	92.51	93.50	94.40	95.30	96.30
51	97.20	98.20	99.10	100.10	101.10
52	102.09	103.10	104.10	105.10	106.20
53	107.20	108.20	109.30	110.40	111.40
54	112.51	113.60	114.70	115.80	116.90
55	118.04	119.10	120.30	121.50	122.60
56	123.80	125.00	126.20	127.40	128.60
57	129.82	131.00	132.30	133.50	134.70
58	136.08	137.30	138.50	139.90	141.20
59	142.60	143.90	145.20	146.60	148.00
60	149.38	150.70	152.10	153.50	155.00
61	156.43	157.80	159.30	160.80	162.30
62	163.77	165.20	166.80	168.30	169.80
63	171.38	172.90	174.50	176.10	177.70
64	179.31	180.90	182.50	184.20	185.80
65	187.54	189.20	190.90	192.60	194.30
66	196.09	197.80	199.50	201.30	203.10
67	204.96	206.80	208.60	210.50	212.30
68	214.17	216.00	218.00	219.90	221.80
69	223.73	225.70	227.70	229.70	231.70
70	233.70	235.70	237.70	239.70	241.80
71	243.90	246.00	248.20	250.30	252.40
72	254.60	256.80	259.00	261.20	263.40
73	265.70	268.00	270.20	272.60	274.80
74	277.20	279.40	281.80	284.20	286.60
75	289.10	291.50	294.00	296.40	298.80
76	301.40	303.80	306.40	308.90	311.40
77	314.10	316.60	319.20	322.00	324.60
78	327.30	330.00	332.80	335.60	338.20
79	341.00	343.80	346.60	349.40	352.20
80	355.10	358.00	361.00	363.80	366.80
81	369.70	372.60	375.60	378.80	381.80
82	384.90	388.00	391.20	394.40	397.40
83	400.60	403.80	407.00	410.20	413.60

Table A-3: Vapor Pressure of Water (Continued)

Aqueous Vapor Pressure Over Water (cont.)					
Temp. (°C)	0.0	0.2	0.4	0.6	0.8
84	416.80	420.20	423.60	426.80	430.20
85	433.60	437.00	440.40	444.00	447.50
86	450.90	454.40	458.00	461.60	465.20
87	468.70	472.40	476.00	479.80	483.40
88	487.10	491.00	494.70	498.50	502.20
89	506.10	510.00	513.90	517.80	521.80
90	525.76	529.77	533.80	537.86	541.95
91	546.05	550.18	554.35	558.53	562.75
92	566.99	571.26	575.55	579.87	584.22
93	588.60	593.00	597.43	601.89	606.38
94	610.90	615.44	620.01	624.61	629.24
95	633.90	638.59	643.30	648.05	652.82
96	657.62	662.45	667.31	672.20	677.12
97	682.07	687.04	692.05	697.10	702.17
98	707.27	712.40	717.56	722.75	727.98
99	733.24	738.53	743.85	749.20	754.58
100	760.00	765.45	770.93	776.44	782.00
101	787.57	793.18	798.82	804.50	810.21

Comparison of ppm_v Calculations

There are three basic methods for determining the moisture content of a gas in ppm_v:

- the calculations described in this appendix
- calculations performed with the slide rule device that is provided with each GE Infrastructure Sensing hygrometer
- values determined from tabulated vapor pressures

For comparison purposes, examples of all three procedures are listed in Table A-4 below.

Table A-4: Comparative ppm_v Values

Dew Point (°C)	Pressure (psig)	Calculation Method		
		Slide Rule	Appendix A	Vapor Pressure
-80	0	0.5	0.55	0.526
	100	0.065	N.A.	0.0675
	800	0.009	N.A.	0.0095
	1500	0.005	N.A.	0.0051
-50	0	37	40	38.88
	100	4.8	5.2	4.98
	800	0.65	0.8	0.7016
	1500	0.36	0.35	0.3773
+20	0	N.A.	20,000	23,072.36
	100	3000	3000	2956.9
	800	420	400	416.3105
	1500	220	200	223.9

Liquid Applications

Theory of Operation

The direct measurement of water vapor pressure in organic liquids is accomplished easily and effectively with GE Infrastructure Sensing Aluminum Oxide Moisture Probes. Since the moisture probe pore openings are small in relation to the size of most organic molecules, admission into the sensor cavity is limited to much smaller molecules, such as water. Thus, the surface of the aluminum oxide sensor, which acts as a semi-permeable membrane, permits the measurement of water vapor pressure in organic liquids just as easily as it does in gaseous media.

In fact, an accurate sensor electrical output will be registered whether the sensor is directly immersed in the organic liquid or it is placed in the gas space above the liquid surface. As with gases, the electrical output of the aluminum oxide probe is a function of the measured water vapor pressure.

Moisture Content Measurement in Organic Liquids

When using the aluminum oxide sensor in non-polar liquids having water concentrations ≤1% by weight, *Henry's Law* is generally applicable.

Henry's Law Type Analysis

Henry's Law states that, at constant temperature, *the mass of a gas dissolved in a given volume of liquid is proportional to the partial pressure of the gas in the system*. Stated in terms pertinent to this discussion, it can be said that the ppm_w of water in hydrocarbon liquids is equal to the partial pressure of water vapor in the system times a constant.

As discussed above, a GE Infrastructure Sensing aluminum oxide probe can be directly immersed in a hydrocarbon liquid to measure the equivalent dew point. Since the dew point is functionally related to the vapor pressure of the water, a determination of the dew point will allow one to calculate the ppm_w of water in the liquid by a Henry's Law type analysis. A specific example of such an analysis is shown below.

For liquids in which a Henry's Law type analysis is applicable, the parts per million by weight of water in the organic liquid is equal to the partial pressure of water vapor times a constant:

$$ppm_w = K \times P_W \qquad (1\text{-}9)$$

where, K is the Henry's Law constant in the appropriate units, and the other variables are as defined on page A-13.

Henry's Law Type Analysis (cont.)

Also, the value of K is determined from the known water saturation concentration of the organic liquid at the measurement temperature:

$$K = \frac{\text{Saturation ppm}_w}{P_S} \quad (1\text{-}10)$$

For a mixture of organic liquids, an average saturation value can be calculated from the weight fractions and saturation values of the pure components as follows:

$$\text{Ave. } C_S = \sum_{i=1}^{n} X_i (C_S)_i \quad (1\text{-}11)$$

where, X_i is the weight fraction of the i^{th} component, $(C_S)_i$ is the saturation concentration (ppm_w) of the i^{th} component, and n is the total number of components.

In conclusion, the Henry's Law constant (K) is a constant of proportionality between the saturation concentration (C_S) and the saturation vapor pressure (P_S) of water, at the measurement temperature. In the *General Case*, the Henry's Law constant varies with the measurement temperature, but there is a *Special Case* in which the Henry's Law constant does not vary appreciably with the measurement temperature. This special case applies to saturated, straight-chain hydrocarbons such as pentane, hexane, heptane, etc.

General Case

Determination of Moisture Content if C_S is Known:

The nomograph for liquids in Figure A-3 on page A-26 can be used to determine the moisture content in an organic liquid, if the following values are known:

- the temperature of the liquid at the time of measurement
- the saturation water concentration at the measurement temperature
- the dew point, as measured with the GE Infrastructure Sensing hygrometer

General Case (cont.)

Complete the following steps to determine the moisture content from the nomograph:

1. Using a straightedge on the two scales on the right of the figure, connect the known saturation concentration (ppm_w) with the measurement temperature (°C).
2. Read the Henry's Law constant (K) on the center scale.
3. Using a straightedge, connect above K value with the dew/frost point, as measured with the GE Infrastructure Sensing hygrometer.
4. Read the moisture content (ppm_w) where the straight edge crosses the moisture content scale.

Empirical Determination of K and C_S

If the values of K and C_S are not known, the GE Infrastructure Sensing hygrometer can be used to determine these values. In fact, only one of the values is required to determine ppm_w from the nomograph in Figure A-3 on page A-26. To perform such an analysis, proceed as follows:

1. Obtain a sample of the test solution with a known water content; or perform a *Karl Fischer* titration on a sample of the test stream to determine the ppm_w of water.

Note: *The Karl Fischer analysis involves titrating the test sample against a special Karl Fischer reagent until an endpoint is reached.*

2. Measure the dew point of the known sample with the GE Infrastructure Sensing hygrometer.
3. Measure the temperature (°C) of the test solution.
4. Using a straightedge, connect the moisture content (ppm_w) with the measured dew point, and read the K value on the center scale.
5. Using a straightedge, connect the above K value with the measured temperature (°C) of the test solution, and read the saturation concentration (ppm_w).

IMPORTANT: *Since the values of K and C_S vary with temperature, the hygrometer measurement and the test sample analysis must be done at the same temperature. If the moisture probe temperature is expected to vary, the test should be performed at more than one temperature.*

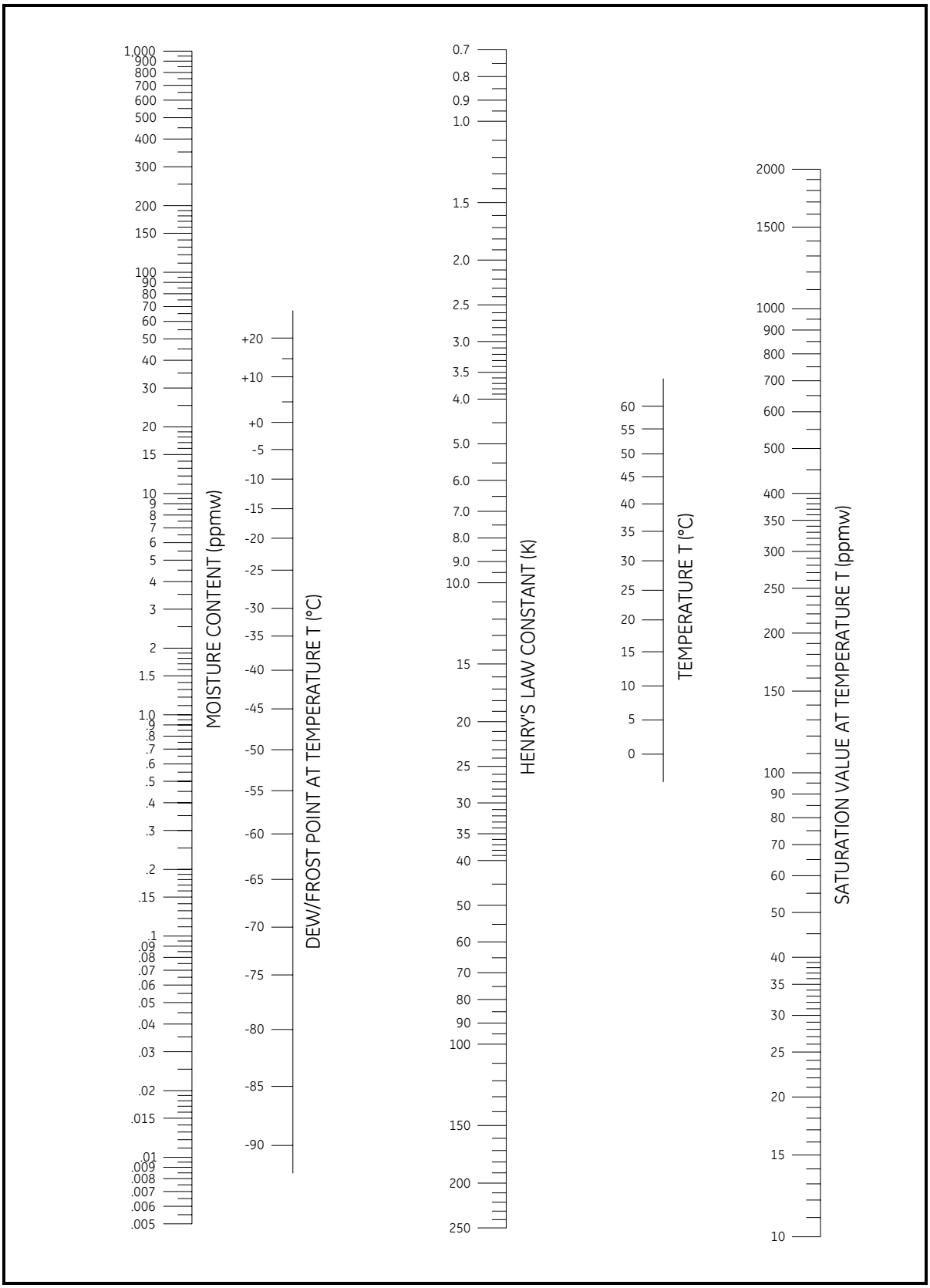


Figure A-3: Moisture Content Nomograph for Liquids

Special Case

As mentioned earlier, saturated straight-chain hydrocarbons represent a special case, where the Henry's Law constant does not vary appreciably with temperature. In such cases, use the nomograph for liquids in Figure A-3 on page A-26 to complete the analysis.

Determination of moisture content if the Henry's Law constant (K) is known.

1. Using a straightedge, connect the known K value on the center scale with the dew/frost point, as measured with the GE Infrastructure Sensing hygrometer.
2. Read moisture content (ppm_w) where the straightedge crosses the scale on the left.

Typical Problems

1. Find the moisture content in benzene, at an ambient temperature of 30°C, if a dew point of 0°C is measured with the GE Infrastructure Sensing hygrometer.
   a. From the literature, it is found that C_S for benzene at a temperature of 30°C is **870 ppm_w**.
   b. Using a straightedge on Figure A-3 on page A-26, connect the 870 ppm_w saturation concentration with the 30°C ambient temperature and read the Henry's Law Constant of **27.4** on the center scale.
   c. Using the straightedge, connect the above K value of 27.4 with the measured dew point of 0°C, and read the correct moisture content of **125 ppm_w** where the straightedge crosses the moisture content scale.
2. Find the moisture content in heptane, at an ambient temperature of 50°C, if a dew point of 3°C is measured with the GE Infrastructure Sensing hygrometer.
   a. From the literature, it is found that C_S for heptane at a temperature of 50°C is **480 ppm_w**.
   b. Using a straightedge on Figure A-3 on page A-26, connect the 480 ppm_w saturation concentration with the 50°C ambient temperature and read the Henry's Law Constant of **5.2** on the center scale.
   c. Using the straightedge, connect the above K value of 5.2 with the measured dew point of 3°C, and read the correct moisture content of **29 ppm_w** where the straightedge crosses the moisture content scale.

Special Case (cont.)

Note: *If the saturation concentration at the desired ambient temperature cannot be found for any of these special case hydrocarbons, the value at any other temperature may be used, because K is constant over a large temperature range.*

3. Find the moisture content in hexane, at an ambient temperature of 10°C, if a dew point of 0°C is measured with the GE Infrastructure Sensing hygrometer.
   a. From the literature, it is found that C_S for hexane at a temperature of 20°C is **101 ppm_w**.
   b. Using a straightedge on Figure A-3 on page A-26, connect the 101 ppm_w saturation concentration with the 20°C ambient temperature and read the Henry's Law Constant of **5.75** on the center scale.
   c. Using the straightedge, connect the above K value of 5.75 with the measured dew point of 0°C, and read the correct moisture content of **26 ppm_w** where the straightedge crosses the moisture content scale.
4. Find the moisture content in an unknown organic liquid, at an ambient temperature of 50°C, if a dew point of 10°C is measured with the GE Infrastructure Sensing hygrometer.
   a. Either perform a Karl Fischer analysis on a sample of the liquid or obtain a dry sample of the liquid.
   b. Either use the ppm_w determined by the Karl Fischer analysis or add a known amount of water (i.e. 10 ppm_w) to the dry sample.
   c. Measure the dew point of the known test sample with the GE Infrastructure Sensing hygrometer. For purposes of this example, assume the measured dew point to be -10°C.
   d. Using a straightedge on the nomograph in Figure A-3 on page A-26, connect the known 10 ppm_w moisture content with the measured dew point of -10°C, and read a K value of **5.1** on the center scale.
   e. Using the straightedge, connect the above K value of 5.1 with the measured 10°C dew point of the original liquid, and read the actual moisture content of **47 ppm_w** on the left scale.

Special Case (cont.)

Note: *The saturation value at 50°C for this liquid could also have been determined by connecting the K value of 5.1 with the ambient temperature of 50°C and reading a value of 475 ppm_w on the right scale.*

For many applications, a knowledge of the absolute moisture content of the liquid is not required. Either the dew point of the liquid or its percent saturation is the only value needed. For such applications, the saturation value for the liquid need not be known. The GE Infrastructure Sensing hygrometer can be used directly to determine the dew point, and then the percent saturation can be calculated from the vapor pressures of water at the measured dew point and at the ambient temperature of the liquid:

$$\%\ \text{Saturation} = \frac{C}{C_S} \times 100 = \frac{P_W}{P_S} \times 100 \qquad (1\text{-}12)$$

Empirical Calibrations

For those liquids in which a Henry's Law type analysis is not applicable, the absolute moisture content is best determined by empirical calibration. A Henry's Law type analysis is generally not applicable for the following classes of liquids:

- liquids with a high saturation value (2% by weight of water or greater)
- liquids, such as dioxane, that are completely miscible with water
- liquids, such as isopropyl alcohol, that are conductive

For such liquids, measurements of the hygrometer dew point readings for solutions of various known water concentrations must be performed. Such a calibration can be conducted in either of two ways:

- perform a Karl Fischer analysis on several unknown test samples of different water content
- prepare a series of known test samples via the addition of water to a quantity of dry liquid

In the latter case, it is important to be sure that the solutions have reached equilibrium before proceeding with the dew point measurements.

Note: *Karl Fisher analysis is a method for measuring trace quantities of water by titrating the test sample against a special Karl Fischer reagent until a color change from yellow to brown (or a change in potential) indicates that the end point has been reached.*

Either of the empirical calibration techniques described above can be conducted using an apparatus equivalent to that shown in Figure A-4 on page A-31. The apparatus pictured can be used for both the Karl Fischer titrations of unknown test samples (see page A-32) and the preparation of test samples with known moisture content (see page A-33).

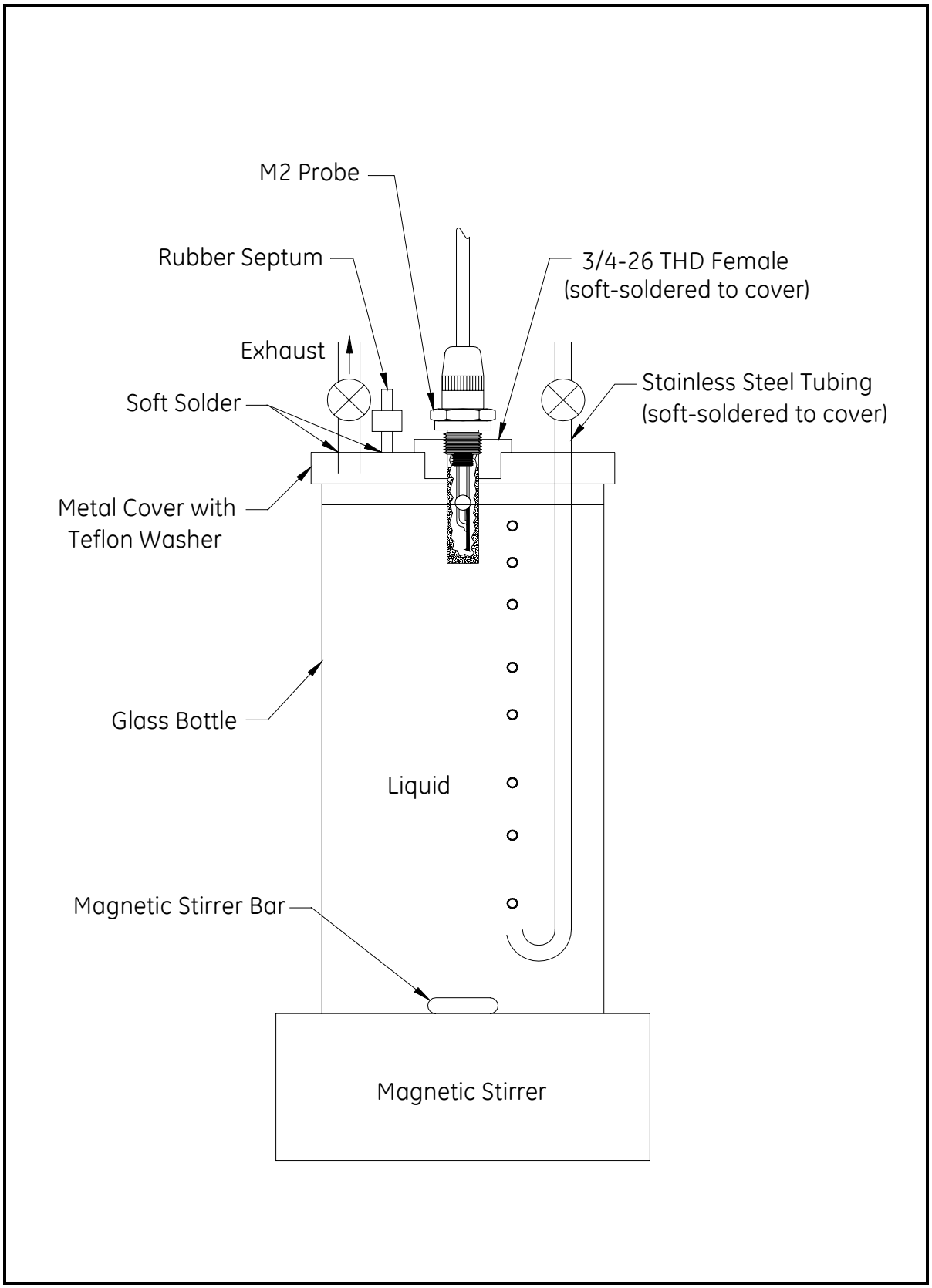


Figure A-4: Moisture Content Test Apparatus

Instructions for Karl Fischer Analysis

To perform a Karl Fisher analysis, use the apparatus in Figure A-4 on page A-31 and complete the following steps:

1. Fill the glass bottle completely with the sample liquid.
2. Close both valves and turn on the magnetic stirrer.
3. Permit sufficient time for the entire test apparatus and the sample liquid to reach equilibrium with the ambient temperature.
4. Turn on the hygrometer and monitor the dew point reading. When a stable dew point reading indicates that equilibrium has been reached, record the reading.
5. Insert a syringe through the rubber septum and withdraw a fluid sample for Karl Fischer analysis. Record the actual moisture content of the sample.
6. Open the exhaust valve.
7. Open the inlet valve and increase the moisture content of the sample by bubbling wet N_2 through the liquid (or decrease the moisture content by bubbling dry N_2 through the liquid).
8. When the hygrometer reading indicates the approximate moisture content expected, close both valves.
9. Repeat steps 3-8 until samples with several different moisture contents have been analyzed.

Instructions for Preparing Known Samples

Note: *This procedure is only for liquids that are highly miscible with water. Excessive equilibrium times would be required with less miscible liquids.*

To prepare samples of known moisture content, use the apparatus in Figure A-4 on page A-31 and complete the following steps:

1. Weigh the dry, empty apparatus.
2. Fill the glass bottle with the sample liquid.
3. Open both valves and turn on the magnetic stirrer.
4. While monitoring the dew point reading with the hygrometer, bubble dry N_2 through the liquid until the dew point stabilizes at some minimum value.
5. Turn off the N_2 supply and close both valves.
6. Weigh the apparatus, including the liquid, and calculate the sample weight by subtracting the step 1 weight from this weight.
7. Insert a syringe through the rubber septum and add a known weight of H_2O to the sample. Continue stirring until the water is completely blended with the liquid.
8. Record the dew point indicated by the hygrometer and calculate the moisture content as follows:

$$ppm_w = \frac{\text{weight of water}}{\text{total weight of liquid}} \times 10^6 \qquad (1\text{-}13)$$

9. Repeat steps 6-8 until samples with several different moisture contents have been analyzed.

Note: *The accuracy of this technique can be checked at any point by withdrawing a sample and performing a Karl Fischer titration. Be aware that this will change the total liquid weight in calculating the next point.*

Additional Notes for Liquid Applications

In addition to the topics already discussed, the following general application notes pertain to the use of GE Infrastructure Sensing moisture probes in liquid applications:

1. All M Series Aluminum Oxide Moisture Probes can be used in either the gas phase or the liquid phase. However, for the detection of trace amounts of water in conductive liquids (for which an empirical calibration is required), the M2 Probe is recommended. Since a background signal is caused by the conductivity of the liquid between the sensor lead wires, use of the M2 Probe (which has the shortest lead wires) will result in the best sensitivity.
2. The calibration data supplied with GE Infrastructure Sensing Moisture Probes is applicable to both liquid phase (for those liquids in which a Henry's Law analysis is applicable) and gas phase applications.
3. As indicated in Table A-2 on page A-5, the flow rate of the liquid is limited to a maximum of 10 cm/sec.
4. Possible probe malfunctions and their remedies are discussed in previous sections of this appendix.

Solids Applications

In-Line Measurements

GE Infrastructure Sensing moisture probes may be installed in-line to continuously monitor the drying process of a solid. Install one probe at the process system inlet to monitor the moisture content of the drying gas and install a second probe at the process system outlet to monitor the moisture content of the discharged gas. When the two probes read the same (or close to the same) dew point, the drying process is complete. For example, a system of this type has been used successfully to monitor the drying of photographic film.

If one wishes to measure the absolute moisture content of the solid at any time during such a process, then an empirical calibration is required:

1. At a particular set of operating conditions (i.e. flow rate, temperature and pressure), the hygrometer dew point reading can be calibrated against solids samples with known moisture contents.
2. Assuming the operating conditions are relatively constant, the hygrometer dew point reading can be noted and a solids sample withdrawn for laboratory analysis.
3. Repeat this procedure until a calibration curve over the desired moisture content range has been developed.

Once such a curve has been developed, the hygrometer can then be used to continuously monitor the moisture content of the solid (as long as operating conditions are relatively constant).

Laboratory Procedures

If in-line measurements are not practical, then there are two possible laboratory procedures:

The unique ability of the GE Infrastructure Sensing probe to determine the moisture content of a liquid can be used as follows:

- Using the apparatus shown in Figure A-4 on page A-31, dissolve a known amount of the solids sample in a suitable hydrocarbon liquid.
- The measured increase in the moisture content of the hydrocarbon liquid can then be used to calculate the moisture content of the sample.
- For best results, the hydrocarbon liquid used above should be pre-dried to a moisture content that is insignificant compared to the moisture content of the sample.

Note: *Since the addition of the solid may significantly change the saturation value for the solvent, published values should not be used. Instead, an empirical calibration, as discussed in the previous section, should be used.*

- A dew point of -110°C, which can correspond to a moisture content of 10^{-6} ppm_w or less, represents the lower limit of sensor sensitivity. The maximum measurable moisture content depends to a great extent on the liquid itself. Generally, the sensor becomes insensitive to moisture contents in excess of 1% by weight.

OR

An alternative technique involves driving the moisture from the solids sample by heating:

- The evaporated moisture is directed into a chamber of known volume, which contains a calibrated moisture probe.
- Convert the measured dew point of the chamber into a water vapor pressure, as discussed earlier in this appendix. From the known volume of the chamber and the measured vapor pressure (dew point) of the water, the number of moles of water in the chamber can be calculated and related to the percent by weight of water in the test sample.
- Although this technique is somewhat tedious, it can be used successfully. An empirical calibration of the procedure may be performed by using hydrated solids of known moisture content for test samples.

Appendix B

Outline and Installation Drawings

Panel Mount Enclosure (#712-1042). B-1

Bench Mount Enclosure (#712-1043) B-2

Board Mount Version (#712-1045) B-3

Interconnection Diagram (#702-212) B-4

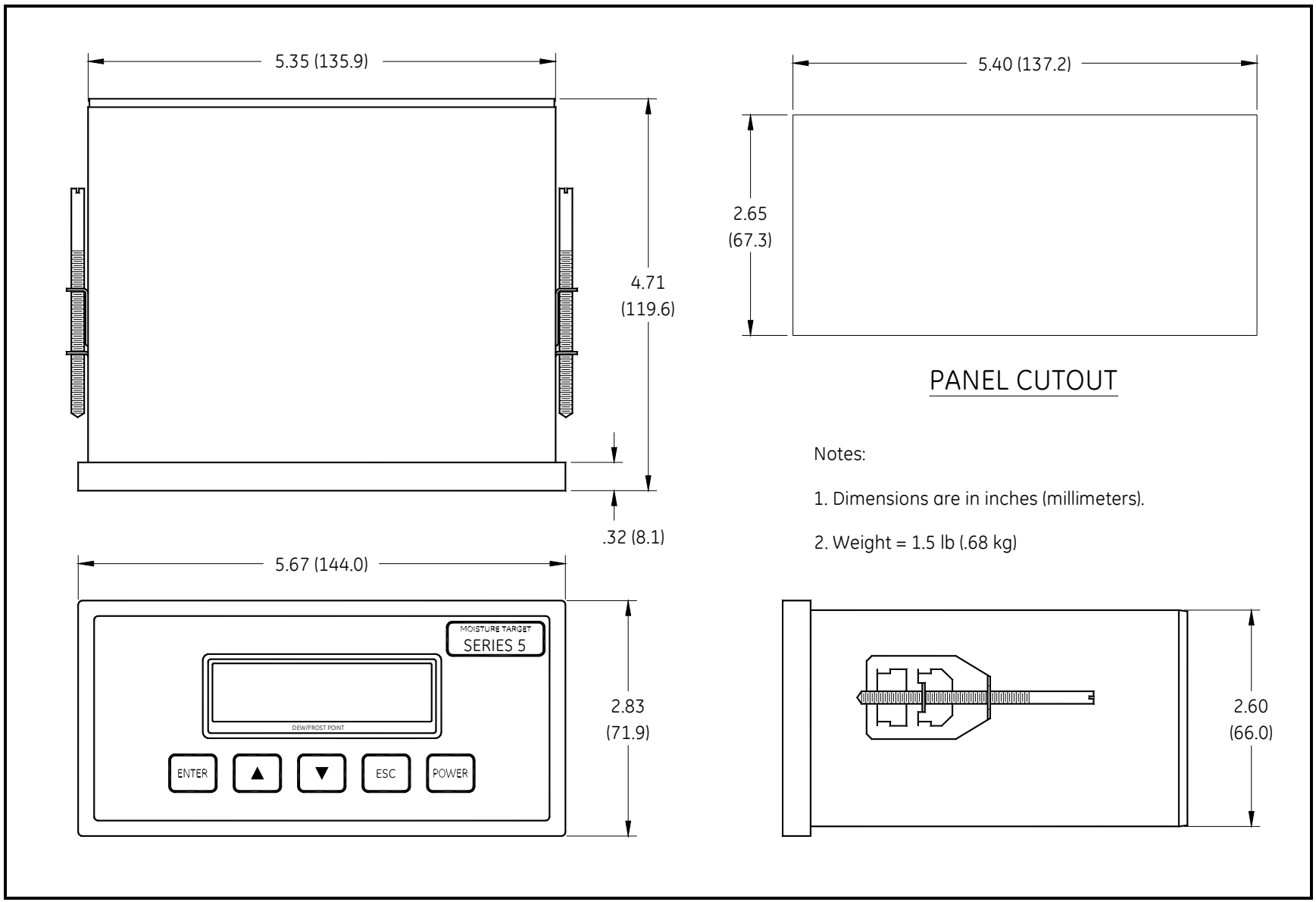


Figure B-1: Panel Mount Enclosure (#712-1042)

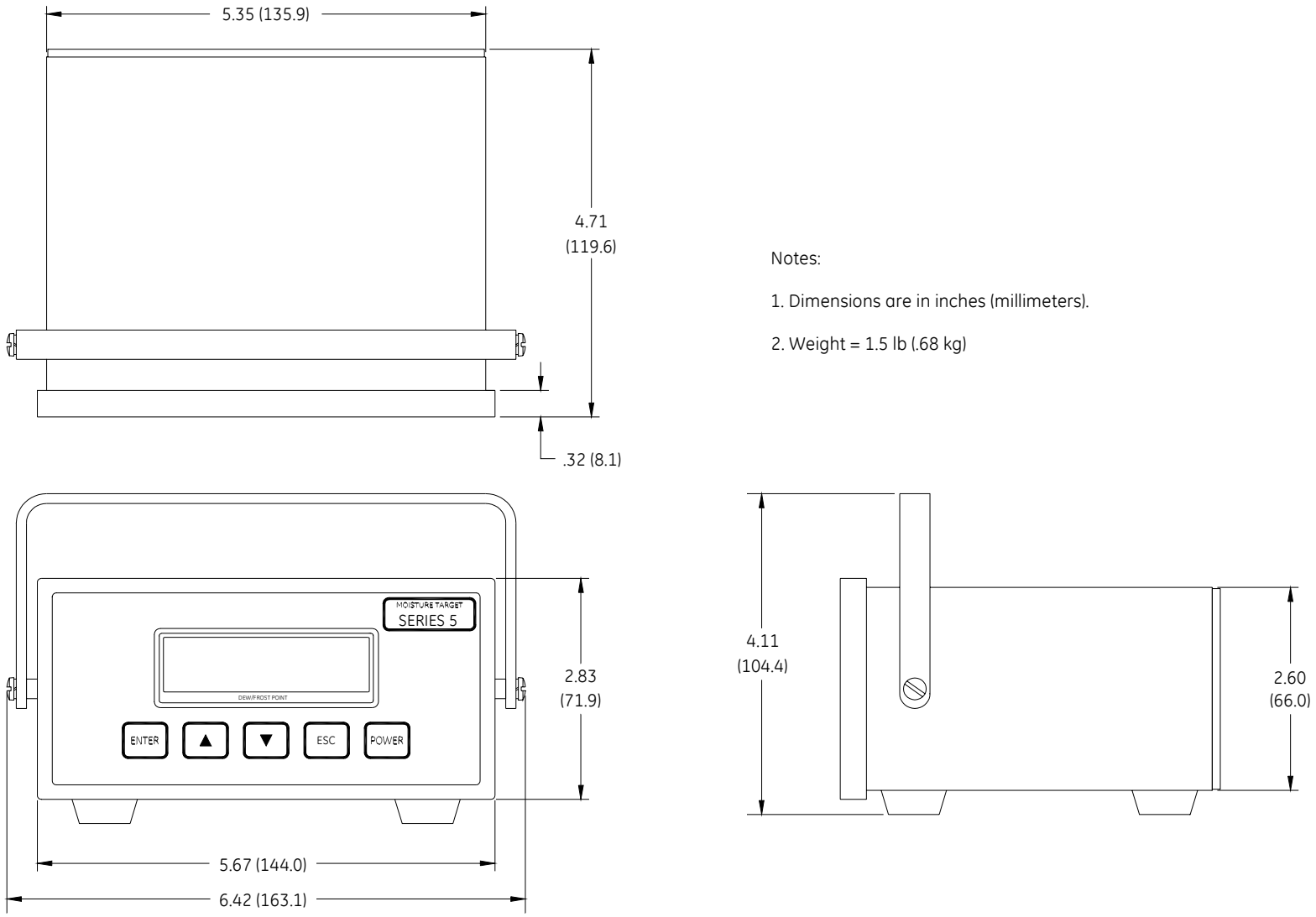
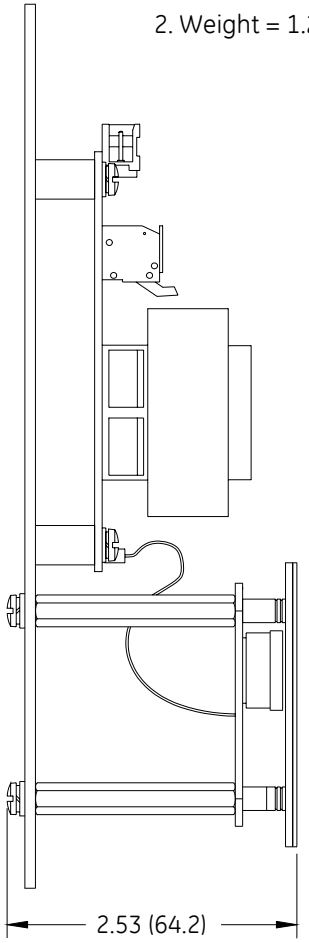


Figure B-2: Bench Mount Enclosure (#712-1043)

Notes:

1. Dimensions are in inches (millimeters).

2. Weight = 1.22 lb (.554 kg)



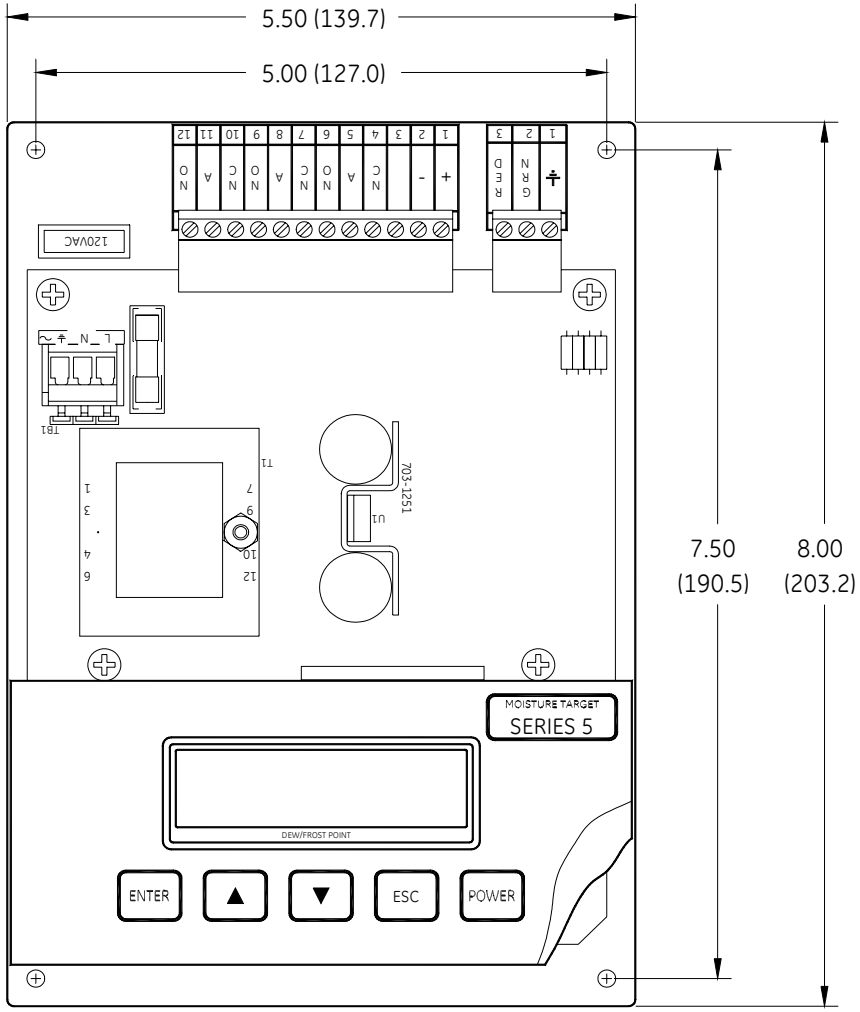


Figure B-3: Board Mount Version (#712-1045)

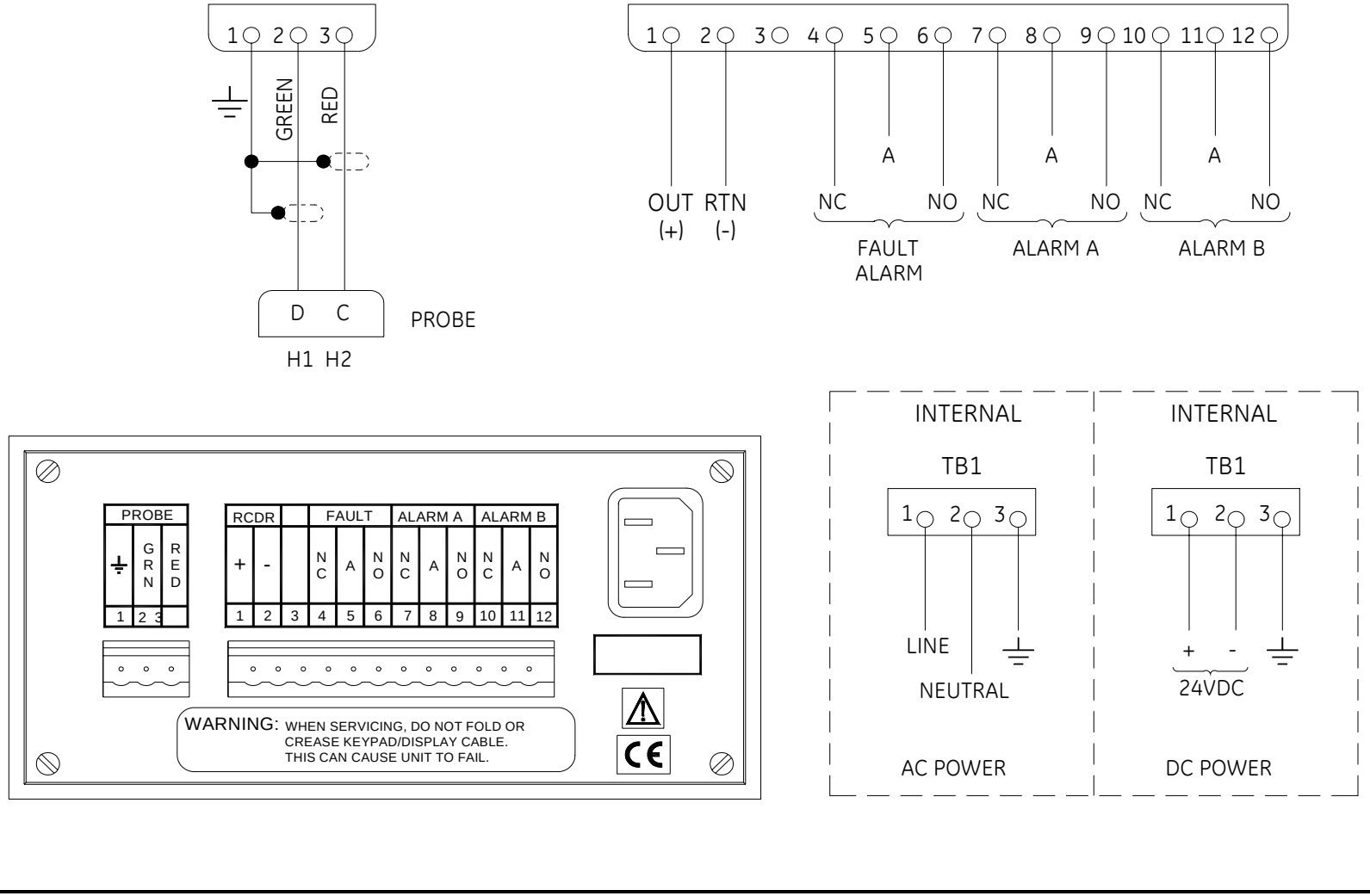


Figure B-4: Interconnection Diagram (#702-212)

Appendix C

Menu Maps

Main and User1 Menu Map. C-1

User2 Menu Map. C-2

Quick Setup Guide C-3

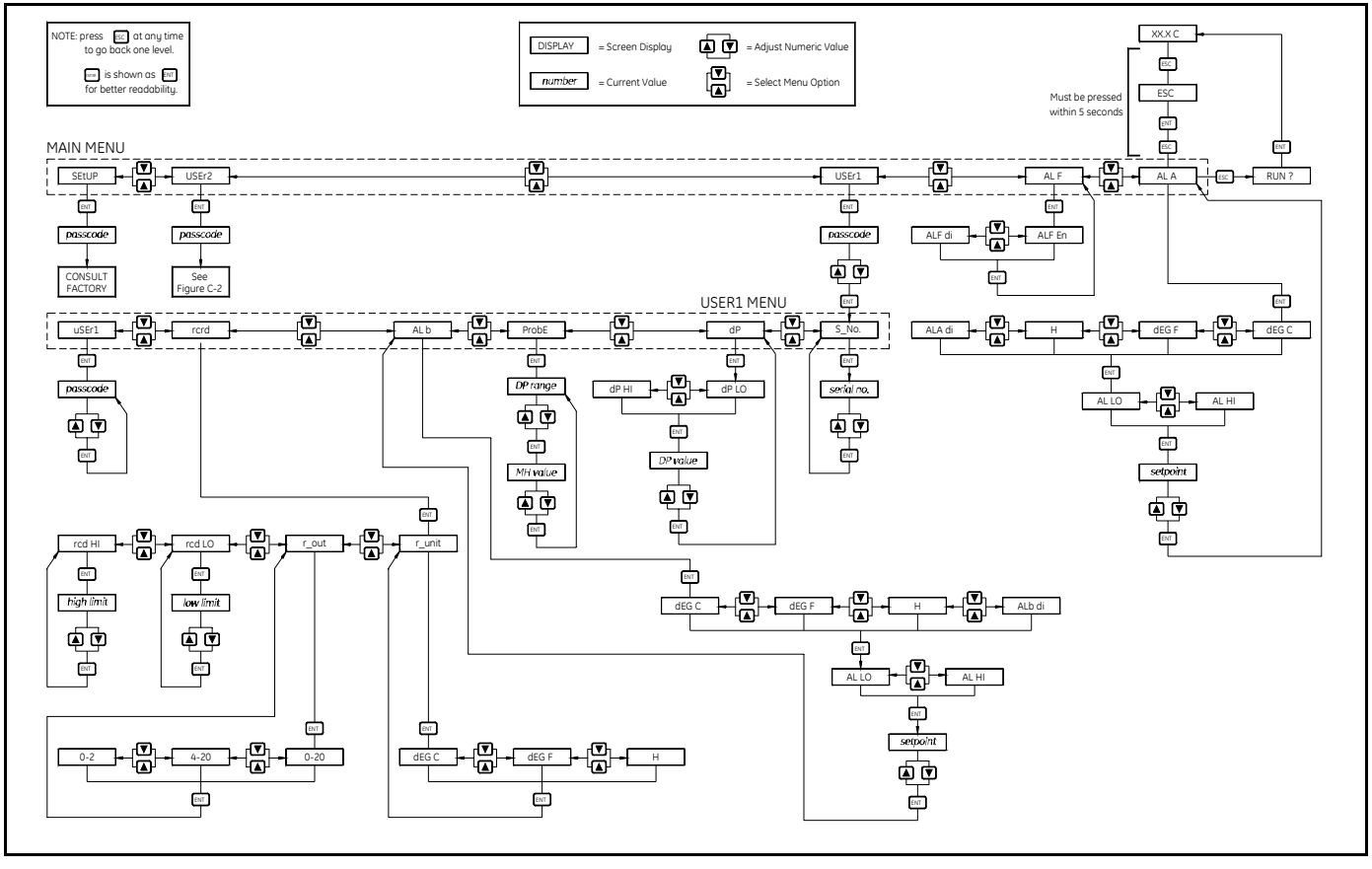


Figure C-1: Main and User1 Menu Map

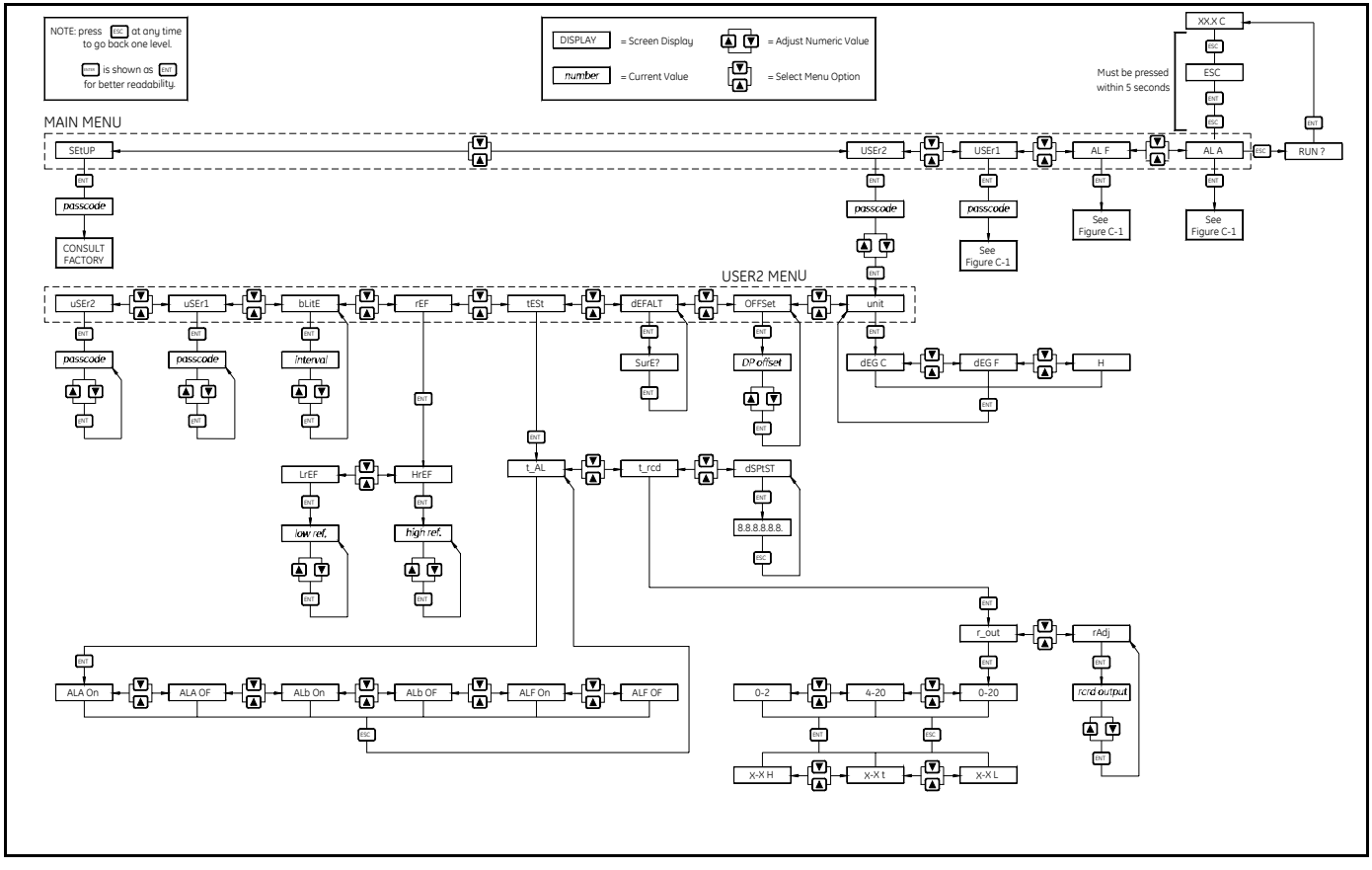


Figure C-2: User2 Menu Map

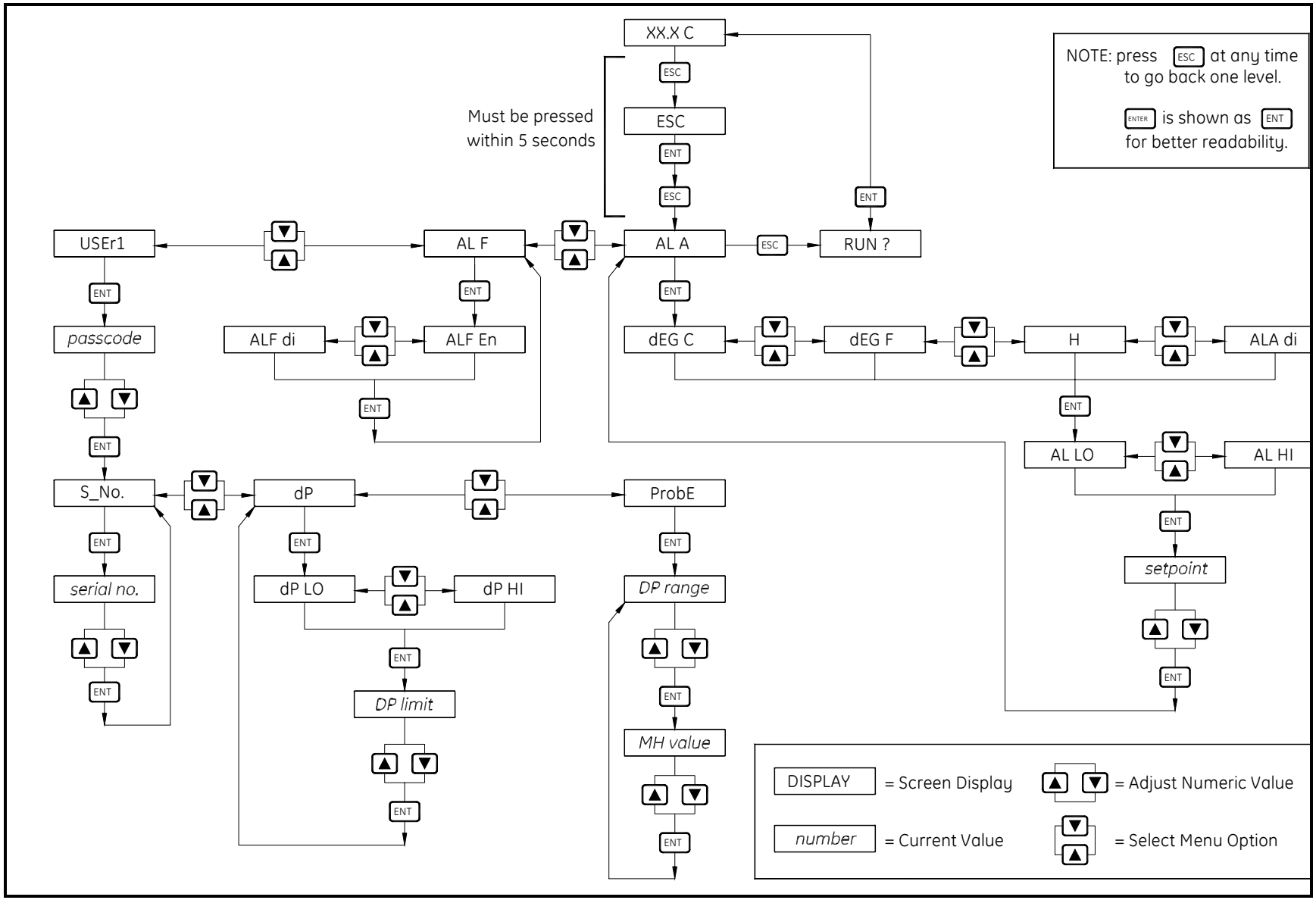


Figure C-3: Quick Setup Guide

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GE Infrastructure
Sensing

DECLARATION OF CONFORMITY

We,

Panametrics Limited
Shannon Industrial Estate
Shannon, County Clare
Ireland

declare under our sole responsibility that the

Moisture Target Series 5 Hygrometer

to which this declaration relates, are in conformity with the following standards:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993+A2:1995, Overvoltage Category II, Pollution Degree 2

following the provisions of the 89/336/EEC EMC Directive and the 73/23/EEC Low Voltage Directive.

The *units listed above and any sensors and ancillary sample handling systems supplied with them* do not bear CE marking for the Pressure Equipment Directive, as they are supplied in accordance with Article 3, Section 3 (sound engineering practices and codes of good workmanship) of the Pressure Equipment Directive 97/23/EC for DN<25.

Shannon - June 1, 2002

Mr. James Gibson
GENERAL MANAGER

CE

NSAI
I.S. EN ISO 9002
Shannon

TÜV
TÜV ESSEN
ISO 9001
U.S.

GE Infrastructure
Sensing

DECLARATION DE CONFORMITE

Nous,

Panametrics Limited
Shannon Industrial Estate
Shannon, County Clare
Ireland

déclarons sous notre propre responsabilité que les

Moisture Target Series 5 Hygrometer

rélatif á cette déclaration, sont en conformité avec les documents suivants:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993+A2:1995, Overvoltage Category II, Pollution Degree 2

suivant les régles de la Directive de Compatibilité Electromagnétique 89/336/EEC et de la Directive Basse Tension 73/23/EEC.

Les *matériels listés ci-dessus, ainsi que les capteurs et les systèmes d'échantillonnages pouvant être livrés avec* ne portent pas le marquage CE de la directive des équipements sous pression, car ils sont fournis en accord avec la directive 97/23/EC des équipements sous pression pour les DN<25, Article 3, section 3 qui concerne les pratiques et les codes de bonne fabrication pour l'ingénierie du son.

Shannon - June 1, 2002

Mr. James Gibson
DIRECTEUR GÉNÉRAL

CE

I.S. EN ISO 9002
Shannon

TÜV
TÜV ESSEN
ISO 9001
U.S.

GE Infrastructure
Sensing

KONFORMITÄTS-ERKLÄRUNG

Wir,

Panametrics Limited
Shannon Industrial Estate
Shannon, County Clare
Ireland

erklären, in alleiniger Verantwortung, daß die Produkte

Moisture Target Series 5 Hygrometer

folgende Normen erfüllen:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993+A2:1995, Overvoltage Category II, Pollution Degree 2

gemäß den Europäischen Richtlinien, Niederspannungsrichtlinie Nr.: 73/23/EG und EMV-Richtlinie Nr.: 89/336/EG.

Die *oben aufgeführten Geräte und zugehörige, mitgelieferte Sensoren und Handhabungssysteme* tragen keine CE-Kennzeichnung gemäß der Druckgeräte-Richtlinie, da sie in Übereinstimmung mit Artikel 3, Absatz 3 (gute Ingenieurpraxis) der Druckgeräte-Richtlinie 97/23/EG für DN<25 geliefert werden.

Shannon - June 1, 2002

Mr. James Gibson
GENERALDIREKTOR

CE

NSAI I.S. EN ISO 9002 Shannon

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